

Fall 2008

# Unveiling the Masculinity of Science: A Journey into the Reactions and Reflections of Female Science Teachers to the Nature of Science

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UNVEILING THE MASCULINITY OF SCIENCE: A JOURNEY INTO THE  
REACTIONS AND REFLECTIONS OF FEMALE SCIENCE TEACHERS TO THE  
NATURE OF SCIENCE

by

TINA M. WILKINS

(Under the Direction of Delores Liston)

ABSTRACT

This study investigated how eight female science teachers in a Consciousness Raising focus group viewed science and how they responded to the message that the nature of science is a masculine, social construct. Using the framework of Feminist Standpoint Theory and Critical Race Feminism, I investigated the reactions and reflections of the participants to the video "Asking Different Questions: Women in Science" (1993). Prior to the video, the teachers completed a short questionnaire and discussed the nature of science. They viewed, discussed, and related the video's message to their lived experiences. I theorized that some teachers would become more aware of the presumed masculine nature of science and relate prior lived experiences.

Before and after the video, participants shared stories of being treated differently from the male students in the classroom. Prior to the video most participants believed the nature of science to be objective, but may contain some subjectivity and biases in it. Seven of the eight teachers recognized that science is not free from social constraints. After the video the most significant change in data occurred as teachers changed their minds about the objectivity of science. All but one shared that she accepted that science

had a social, subjective nature. All the participants recalled stories where they felt oppressed in science classes and/or society due to being female.

The over-arching themes from the study are lack of reflection and need for critical reflection and analysis, silencing, (due to intimidation, learned helplessness, and oppression), and inequitable opportunities in the classroom and in career choices. The significance of this study is found in unveiling the hegemonic nature of science and opening doors for discussion and reflection among teachers. Additional research is needed to determine if the teachers will apply their newfound knowledge and analysis to current pedagogical practices. Recommendations for further research center on studying experiences of teachers and subsequent impact on their current practices and beliefs. This study exposes and names the masculine hegemonic nature of science and gender biases which occur in schools and society as seen through the standpoints and experiences of female science teachers.

INDEX WORDS: Consciousness-Raising, Feminist Standpoint Theory, Critical Race Feminism, Nature of Science, Middle Grade Science Teachers, Lived Experiences

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by

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Partial Fulfillment of the Requirements for the Degree

DOCTOR OF EDUCATION

STATESBORO, GEORGIA

2008

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December 2008

## DEDICATION

This dissertation is dedicated foremost to my loving husband, Ty, and two children, Jacob and Hannah. Without their constant support and love, I could not have finished this undertaking.

Thank you for always loving me.

My dissertation is also dedicated to two dear friends lost to cancer during my dissertation writing, Bridget Hammond and Karen Bingham-Lewis. I felt their love and guidance throughout the dissertation process. I am sure they are celebrating with me.

I miss you girls.

## ACKNOWLEDGMENTS

I would like to thank my committee members for their constant support and encouragement during my dissertation process. I send a special thank you to my chair, Delores Liston, for the countless hours she spent laboring over my drafts and encouraging me to dig deeper to find myself and my work. With her help, I was able to do what seemed insurmountable at times. Thank you.



## TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS .....	7
LIST OF TABLES .....	11
CHAPTER	
1 SCIENCE AS A SOCIAL STATE .....	12
Social, Political, and Historical Factors of Science Practice .....	12
My Journey .....	18
2 THEORETICAL FRAMEWORK .....	23
Feminist Standpoint Theory .....	24
Critical Race Feminism .....	30
Harmony of Feminist Standpoint Theory and Critical Race Feminism .....	34
Literature Review .....	35
<i>Culture of Science</i> .....	36
<i>Teachers Women and the Nature of Education</i> .....	40
<i>Science Teachers' Attitudes, Beliefs, and Practices</i> .....	44
<i>Achievement of Females in Science</i> .....	50
<i>Women's Ways of Knowing</i> .....	55
<i>Culture and Gender</i> .....	59
3 METHODOLOGY .....	61
Consciousness-Raising Group .....	64
Data Collection and Analysis .....	66
Conclusion .....	70

4	REVEALING REACTIONS AND REFLECTIONS .....	71
	Pre and Post Video Opinions: Changing Attitudes .....	94
5	CONSCIOUSNESS RAISING: BRICK WALL REMOVAL .....	100
	Culture of Science versus Nature of Science. ....	100
	Significant Findings .....	102
	Reflection and Analysis of Science .....	103
	<i>Objectivity of Science</i> .....	103
	<i>Masculine Science</i> .....	109
	Silencing Experiences .....	111
	Loss of Opportunities .....	115
	<i>Stereotyping in the Classrooms</i> .....	116
	<i>Stereotyping in Careers</i> .....	118
	Culture and Gender .....	122
	Significance of Stories.....	126
	Recommendations for Future Research .....	130
	Strength and Limitations .....	132
	Summary and Conclusion .....	134
	BIBLIOGRAPHY .....	137
	APPENDICES	
	A INFORMED CONSENT .....	153
	B SCREENING PROCEDURES FOR POTENTIAL PARTICIPANTS .....	156
	C POSSIBLE GUIDING QUESTIONS .....	158
	D OPINIONS PRIOR TO AND AFTER C-R EXPERIENCE .....	159

E DATA ANALYSIS SPREADSHEET .....160

## LIST OF TABLES

	Page
Table 1: Pretest Results.....	95
Table 2: Comparison of Opinions Prior to and After C-R Experience.....	97

## CHAPTER 1

### SCIENCE AS A SOCIAL STATE

#### Social, Political, and Historical Factors of Science Practice

Science is the driving force in our nation's technological advancements for war, industry, and consumerism. "Science is, at multiple levels, the very stuff that U.S. education is made out of" (Weaver, Anijar, & Daspit, 2004, p. 79). How we teach science and what we claim to be scientific knowledge becomes of utmost importance in curriculum studies (Alters, 1997). In science and math we still practice traditional curriculum development funded by national money for the purpose of "international economic competition" (Pinar, Reynolds, Slattery, & Taubman, 1995, p. 6). Our political policies find their roots in science and technological growth influencing decisions on how money will be spent and who will receive funding. Our government funds national science, math, and technological research which support this cultural scientific machine.

In traditional science, an arrogance exists that the reflected image from research questions, methodology, and interpretation is value free, desire free, and belief free. However, feminists recognize the hegemonic nature of this conventional view of science and call for using subjectivity to increase knowledge (Harding, 1991). Historically, Frances Bacon first recognized and expressed "the aims of science as the control and domination of nature" (Keller, 1985, p. 33). Man's desire to control nature is paralleled by patriarchal domination of women (Griffin, 1978).

Western science developed during the seventeenth century, historically a patriarchal period; as such women were excluded from the foundation of scientific thought and development. Scientific thought developed as masculine thought with the

exclusion of female voices. This initial exclusion of women from science continues even today. The National Research Council's (1996) National Science Education Standards engaged in a "discourse of invisibility" by not addressing ethnic, socioeconomic, and gender issues (Rodriguez, 1996). By naming what is missing, we are able to acknowledge social issues that are invisible in the standards, compromising their equality.

The concern of my dissertation lies with science teachers, as they are messengers of modern educational practices which often support hegemonic practices. As such, I believe it is vital for my dissertation to investigate how female science teachers view science and how they will respond to the idea that science is a masculine, hegemonic construct. I formed a Consciousness-Raising Group of 8-10 female science teachers. After viewing a video with the message of the masculine, hegemonic nature of science, I recorded their responses. I theorized that some teachers would become more critically conscious of the presumed masculine nature of science and would be able to relate prior experiences which support this point.

Critical consciousness entails decisive understanding and awareness of how cultural myths attempt to subjugate us (Donovan, 1985). Empowerment starts when we realize who has the power and how that power has controlled our lives. To gain control and power, we must unlearn earlier knowledge, schema, and assumptions acquired from our lived experiences. With knowledge and education, ignorance of social systems that contain oppression, inequality, and biases could be changed. Thus one will become more conscious of hegemonic social structures. "The world which brings consciousness into existence becomes the world of that consciousness" (Freire, 2001, p. 83). With

consciousness, we are able to set aside our perceptions and begin to understand who is controlling our world and how to liberate our own voices from silence. Freire (2001) refers to this concept as conscientização. One of the central goals of conscientização is a group identity which provides a positive experience counter to the hegemonic societal myth (Donovan, 1985). According to Shreve (1989) Consciousness Raising groups stemming from the 1970s provided a positive experience for women fighting oppressive ideologies and allowed for personal and political awareness to thrive. Levit (1998) contends that C-R groups “promote self-esteem and foster awareness of various certain forms of oppression” (Levit, 1998, p. 149).

The idea for this study emerged for me as I read books required in my coursework. I had unquestionably accepted the presumed value-free, objective stance of science and through my readings became aware that science is a value-laden social construct. My own conscientização, or shattering of former beliefs, began as I started to see for the first time, the hegemonic nature of society and science, and how power is used as an oppressive tool in society and the classroom. Through deeper study and observation in my own science classroom, I began to see the hegemonic nature of science and the resulting disparity of female achievement in science. Unveiled before me in my readings were the subtle, insidious ways in which oppression and control reign freely; often unrealized and unchallenged in science and in society. I knew that I had prior experiences which supported this view. I begin to question other teachers’ awareness of the hegemonic nature of science and if they had experiences that also supported the message of the hegemonic nature of society and science.

The intent of my study is to expose the masculine hegemonic nature of science.

My research questions are:

1. What do female science teachers in a focus group believe about the masculine hegemonic nature of science prior to watching a video about sexism in science?
2. What do female science teachers in a focus group believe about the masculine hegemonic nature of science after watching the video?
3. How will female science teachers in a focus group respond to the video about sexism in science?
4. Can female science teachers connect the message in the video of the hegemonic nature of science to real life examples from their past experiences?

As a curriculum studies student, I believe that investigating the viewpoints of female science teachers through a lens of Feminist Standpoint Theory and Critical Race Feminism is essential to the field of curriculum studies. Feminist Standpoint Theory challenges the objective claims of science and attempts to strengthen scientific claims by acknowledging the social side of science (Harding, 1991). Critical Race Feminism addresses the intersection of race, gender, and power relationships (Wing, 2003). The significance of this study is found in unveiling the hegemonic nature of science and opening doors for discussion and reflection among the focus group. Additionally, teachers may become more aware of their own experiences and be able to relate those experiences to power constructs in science and society. Maher (2002) states, “Practicing and prospective teachers can benefit from thinking about their expectations and



assumptions” (p. xiii). Thus, my study is significant in the curriculum field. As teachers reflect on the power constructs in society they may be more able to recognize it in the classroom and the larger field of curriculum. Research shows that teachers’ lived experiences, attitudes, and beliefs guide their practice in the classroom (Maher & Ward, 2002; Halai, 2004; Argyis & Schon, 1980) and how we teach science is important in curriculum studies (Alters, 1997). Teachers may change their practices to address the false pretense that science is objective and value-free. Teachers and students learning to challenge hegemonic constructs in society is a possible significant outcome of this research study. Teachers will become more conscious of powerful constructs that direct their own lives and the lives of their students.

The focus of this study was to investigate how teachers reacted to the message that science is a masculine construct. Additionally, I question if teachers can connect this message to prior experiences. Depending on their level of critical awareness of the patriarchal hierarchy in society, education, and science, the women science teachers participating in this study may not distinguish how social constraints have influenced their lived experiences. In fact, as Grumet (1988) argues, “If we ask women who teach to talk about their work in the language that dominates the discourse of schooling, we invite language that celebrates system and denies doubt, that touts objectives and denies ambivalence, that confesses frustration but withholds love” (p. 59). I invite the participants of my study to use a language of freedom and emotion, unlike normal discourses of schooling. Donovan (1985) suggests allowing women to focus on not only critical thinking, but also the non-rational and intuitive parts of life.

I am interested in researching the reactions and reflections of women middle grades science teachers to observe if they will accept or reject the message of the masculine hegemonic nature of science and if they will connect it to prior experiences. Research indicates that teachers' practices are often based on their prior experiences (Ginn & Watters, 1999; Halai, 2004). Science gender equity research points to teaching practices that favor males (Tindall & Hamil, 2004; Sadker & Sadker, 1994) and gender being an influential agent in the lived experiences of female teachers and their awareness of current practice (Smulyan, 2000). Female teachers experienced social and political influences in their science education (Debacker & Nelson, 2000; Sonnert, 1995). I think it is crucial for teachers to reflect on the nature of science and their past experiences to become more conscious of how their practices and beliefs have been formed.

Being a woman and a science teacher, acquiring science educational experiences both as a student and as a teacher, I am interested in how other female science teachers perceive the nature of science. By studying the reactions of teachers to the video, I expand my understanding of their beliefs about the nature of science and their own experiences. I expect that as a woman teacher gains an understanding of her experiences in and out of the science classroom she may enhance her self-awareness. Teachers must be "aware of their own journeys, their own struggles, and their own limitation as gendered, raced, and classed members of our society" (Maher & Ward, 2002, p 101). Wing (2003) asserts that any research question must begin with the starting point of asking myself, "Why are you interested in this?" (p. 85). As such, this study is essential to me personally and professionally, because I have experienced marginalization in

society and in the classroom due to being a female, and have unknowingly marginalized others while operating within science's patriarchal structure. Additionally, through conducting this research, I will expand my understanding of my own experiences and how they have influenced my thinking. Grumet (1988) states that what we are seeking is the "dialectical interplay of our experiences in the world and our ways of thinking about it" (p. 67).

### My Journey

In eighth grade, I thought my job as the "lab equipment specialist" to be an exceptional job. I failed to identify that I was being denied the opportunity to participate in experiments, dissections, and discussions that would have aided in my scientific understanding. Being silenced in the classroom, I was denied the opportunity to verbalize my learning and construct thoughts that would aid in my understanding of scientific theory and practice. I recall events through middle and high school where boys took the equipment from me, and I had little opportunity to participate. The male students' self-confidence and learning increased as they completed and discussed the experiments, while I stood quietly aside following their lead as this was my socially defined role.

Reduced solely to note-keeper, I held very little interest in the experiments because science was something boys were good at, not girls. Many researchers have found this low self-confidence of females is a common experience for girls in middle to high school (Maher & Ward, 2002; Sadker & Sadker, 1994).

Even in high school, my chemistry teacher showed an apparent physical interest in me. I knew I would do well in his class just because he 'liked' me. He spent extra time talking with me before and after each class about life, music, and love. Although, I never

saw him outside of school, it was obvious that he was more concerned with me than with my understanding of science. I knew my male friends would complete the labs for me. Since my teacher placed his interest in me, not my scientific achievement, I placed little attention on learning the content. I learned quickly that sometimes a girl could get by academically in her science classes on her personality and looks. I did well in his class, but failed to grasp the scientific concepts or develop an interest in science to explore more advanced science classes. These types of marginalization inhibited my science learning. I finished all my courses with good grades, but lacked the interest and knowledge to pursue a science interest in college.

Being a good student, I was able to joint enroll in college and skip my senior year in high school. I began Kennesaw College at the age of 17. Unsure of what degree to pursue, I quickly found myself being led into a Bachelor of Business Administration degree by a handsome young man who pursued the same interest. I remember my basic science classes in college being very interesting. A female teacher taught my first Biology class, and I was so intrigued that I couldn't wait to go each day. However, a science degree did not seem to be an option because business seemed to be a more appropriate choice that would offer more job opportunities than a science career. I graduated at the age of 21, young and single with a BBA in Marketing.

The business world did not seem eager to hire a young, single female with a marketing degree. Eventually, I returned to college for my post-baccalaureate in education. I thought a teaching career would match the schedule of my children that I hoped to have one day. Also, I thought I would more easily secure a job as a teacher than as a marketing professional.

During my post-baccalaureate program, the science classes interested me the most, yet I pursued early childhood education, because this field seemed to offer more jobs for young women. I began teaching and let my science interest fall aside as I struggled to meet the needs of 31 fifth graders. Several years later, I began my Masters in Education with a focus in Middle Grades Science. My second semester a female science teacher somehow could see my deep interest in science that had been ignored, and she aimed to uncover it. My fascination with science once again surfaced. We developed a close relationship for about a year. I even taught the 2-week summer science program for at-risk 8<sup>th</sup> graders at North Georgia College. Additionally, I went away for a week at Tremont Science Institute in the Great Smokey Mountains to be immersed in nature and learn more about how to teach science to middle schoolers. I finally received the support, encouragement, and background knowledge to release my ignored interest in science. My life had mostly been about doing what others wanted me to do or expected me to do. I had not really pursued an interest of my own, because I could not identify what I wanted. Grumet (1988) refers to this process as “thinking back through our mothers” (p. 190). I now realize that I have modeled my mother’s silence, her ignoring/ignorance of her own dreams and mine, and her succumbing to the wills of the patriarch, my father. I surrendered to patriarchal expectations, as many women do even when a male was not literally present. This happened during my life by denying my desire for scientific study, and assuming a traditional career choice that would be convenient for my spouse and future children. I now realize that science is actually something I am interested in doing.

At this point in my life I had not become conscious of my actions and how they had been a reflection of my experiences as one of four females ruled by a dominating

father. I continued teaching and pursued my Education Specialist in Middle Grades Science at West Georgia. I did not find the program particularly interesting. In fact, I now realize that the program actually reduced me to a note taker again as one male science instructor used me to prepare his PowerPoint slides in exchange for independent study hours. After this program, I began to understand the importance of science in elementary school. Teaching fourth grade, I sought to apply science to my students' lives through hands-on experiments and projects, not just read about it. I could see how all the areas of science were connected and sought for my students to gain a deeper appreciation and see the same connections. I am now considered the science specialist in my school. My students remember their fourth grade year as a time of "fun science when they learned a lot." Additionally, I was nominated for the Presidential Math and Science Excellence in Education Award in 2006.

My experiences as a female, student, and teacher frame my standpoint as a science educator and curriculum theorizing student. From these identities I construct my thoughts regarding science, education, and what it means to be female in our society. I aim to synthesize these views to construct a basis from which to study the experiences of others. We each hold a unique combination of experiences; yet at the intersection of some of these experiences similarities can be found between our personal experiences and the experiences of others. I assert that from the ways I now understand these experiences that I have realized that I have an obligation to facilitate positive social change through my research. Permeating my work now is a passion for progressive change, and I have a desire to promote awareness of inequities existing in social structures. I believe that a feminist pedagogy is the best way in which to bring about

these changes as it seeks to raise a critical awareness, educating and empowering others for collective change (Mayberry & Rees, 1997). “At its core, feminist pedagogy is a commitment not only to interdisciplinary knowledge and process learning but to the development of a critical consciousness empowered to apply knowledge to social action and social transformation” (Mayberry & Rees, 1997, pp. 68-69).

Feminist pedagogy seeks to begin research from the lives of those marginalized, critiquing the dominant discourse to challenge hegemonic reality (Harding, 1991). Feminism is a liberatory political movement vying for social change to include the lives of all in science (Harding, 1986). Feminist pedagogues welcome critiques and alternatives to the traditional way of thinking and established hierarchies (Stovall, 2005). Unger (2001) states that Consciousness-Raising groups formed the groundwork of modern feminist theorizing and pedagogues and empowers women for personal and social change. C-R groups focused on raising personal awareness of “a central tenet of the movement: the personal is political” (Biaggio, 2002, p.6).

In my study I investigated the reactions of a female science teacher Consciousness Raising group to a video with the message that science is a masculine hegemonic construct. Additionally, the group shared any lived experiences in or out of the classroom that surfaced after watching the video. Teachers were encouraged to use their intuition and subjective languages to relate their experiences to the video. Liberatory feminist seek to raise awareness of subjugation in society and this commonly occurs through groups (Donovan, 1985; Shreve, 1989; Levit, 1998; Unger, 2001; Jowett & O’Toole, 2006).

## CHAPTER 2

### THEORETICAL FRAMEWORK

As I seek to develop the theoretical framework of my study, I understand my own standpoints play a role in the formation of my work and my perception of others and their work. My study is framed in Feminist Standpoint Theory and Critical Race Feminism. As a female, I have experienced subjugation and oppression on many levels, thus I claim the position of a feminist and frame my study with Feminist Standpoint Theory.

Additionally, I see the subjugation of others due to race, class, gender, and sexuality. For this reason my theoretical framework considers the oppression of others and is framed with Critical Race Feminism.

“Feminism is the affirmation of all life forms without exploiting any” (Kay Hagan, 1986 workshop). With this idea in mind, I designed a Consciousness-Raising focus group study guided by the theoretical framework of Feminist Standpoint Theory and Critical Race Feminism. I have chosen these two theories as I am a white, female teacher seeking to study the standpoints of other female teachers who may have been marginalized due to gender, race or a combination of gender and race. In my attempt to position myself as a feminist who is against any form of oppression or exploitation, I include Feminist Standpoint Theory and Critical Race Feminism as a way to acknowledge the unique position of women of any color as their oppression includes the intersection of race and gender. Critical Race Feminism is “a race intervention in feminist discourse, in that it necessarily embraces feminism’s emphasis on gender oppression within a system of patriarchy” (Wing, 2003, p. 7). White is considered a race and women experience life at the intersection of race and gender, thus it is important to include



Critical Race Theory in my study to acknowledge that all women of all colors experience a unique standpoint based on the intersection of race and gender.

In this section I will first discuss the tenets of Feminist Standpoint Theory and then Critical Race Feminism. After a discussion of each theory, I will review the harmony of these two theories and then provide an extensive literature review of the culture of science, teachers, women and the nature of education, teacher attitudes, beliefs and practice, the achievement of girls in science, women's ways of knowing, and culture and gender.

### Feminist Standpoint Theory

“Scientific processes were and are social processes, of course, that both enhance and limit the role that nature can play in legitimating information as knowledge and truth” (Harding, 1998, p. vii). Science is a tool, and the product of its use is determined by who uses it and how it is used. As a feminist, I recognize that political feminist thought impacts my understanding of science curriculum studies. With Feminist Standpoint Theory, I am growing in my understanding of the nature of science and scientific methods shown in models and narratives which ignore feminist thought. Feminist Standpoint Theory acknowledges those who are often marginalized, and allows me to become familiar with the divergent views of those most often left out of research.

Feminist Standpoint Theory draws on the Marxist idea of work shaping identities and knowledge of individuals. The material condition of the proletariat is the foundation of Marxism, while the foundation of feminist standpoint starts with the lives of women or other subjugated groups (Muted Group Theory Excerpts, 2005). Feminist Standpoint Theory originates in Hegel's explanations of the master's domination over the slave

(Harding, 1986). In traditional scientific claims/constructions, male domination gives us only a partial understanding, but women's suppressed position would provide a vantage point to add to the epistemological base giving "more complete and less perverse understanding" (Harding, 1986, p. 24). Science should be more than obtaining cold, abstract knowledge as we are bound to our world in a web of interdependence (Harding, 1986). The narrow traditional way of thinking about science has brought modern science under scrutiny by a diversity of groups. Liberatory groups representing people of various races, classes, genders, and sexualities struggle against the subordinate status often assigned to them. Women and other minorities, including people in third world countries, are affected by scientific superindustrialism and lack a role in the development of scientific research and scientific discourses (Ross, 1996). In such a power relationship, the ones being oppressed have less concern with keeping the status quo, and thus are more open to discourses promoting change.

Harding (1991) and Haraway (1988) challenge traditional science and assert basic tenets of Feminist Standpoint Theory. First, I will discuss each tenet and then explain their interdependence and my beliefs. The first tenet is that all views are only partial and hold some biases. Secondly, all knowledge is linked to social structure with these structures having hierarchies. Additionally, Feminist Standpoint Theory calls for critical reflexivity and stronger objectivity in research (Campbell, 2004).

Harding (1991) and Haraway (1991) contend that all views are partial and contain biases, yet they provide a way in which to view the world from the experiences and standpoints of the subjugated in contrast to the norm, the White male perspective. Standpoint theory emphasizes "the social locatedness of all knowers and calls into

question the fundamental premise that science presents a transcendent objectivity or view from nowhere” (Whelan, 2001, p. 18). Traditional scientific knowledge is assumed to have an impartial, objective view. Haraway (1988) refers to this all knowing, view from nowhere as the “god-trick”. The “god trick” of modern science is the philosophy of science that justifies itself as speaking from nowhere, not situated from any one place (Haraway, 1988). Harding (1991) argues that the hegemonic nature of science acts as a barrier to keep girls and women out due to their socially constructed identities. It is only when we begin research from their social locations, from their identities that we will begin to break the barriers. In Feminist Standpoint Theory, views of the marginalized groups often are considered a privileged view of reality, not “The Truth”, but a less distorted view than that held by the dominant groups (Whelan, 2001; Harding, 1987). Put another way, Haraway (1991) refers to subjugated standpoints, views from below, as standpoints which offer a preferred view because they “promise more adequate, sustained, objective, transforming accounts of the world” (p. 191). These views are often established hierarchies in schools and society.

Feminist Standpoint Theory acknowledges that all knowledge is linked to social structures with established hierarchies. I recognize my position as a white, female, middle class, science teacher. These identities are both constructed by me based on my experiences and assigned to me by societal norms. Harding (1991) addresses identities as social constructs as well, and argues that social identity lends one to a social location based on race, class, gender, sexuality, and ethnicity. One’s social position determines the level of understanding of the dominant discourses in society. This social location is made up of many identities constructed from assigned roles in society and from experiences in

one's life. As such, I agree with Harding that we are products of our social location and experiences from some of these locations can offer a better view of oppression.

Oppression provides another perception of powerful practices that those in power often do not themselves recognize. Any particular person can provide a view which others may not see. Different discourses are a result of different social locations and experiences. Women can understand sexism better than men, yet men can choose to listen and attempt to understand the oppression of women. However, not all women understand sexism in the same way. Just because one is female does not mean that one will necessarily acknowledge the patriarchal, hegemonic structure of society. That being said, I believe females can become more aware of their oppression through reflection and discussion of their experiences with others. Feminist Standpoint Theory holds that when a woman becomes more conscious of the powerful and often subtle hegemonic influences in her life, she often will acknowledge her unrealized potential.

The hierarchy of these social structures of knowledge has a base formed by subordinate groups manipulated by decision makers, while the top is made of the dominant groups making the decisions. By acknowledging the positions of marginalized groups at the base, Feminist Standpoint Theory tries to equalize power distribution and recognize the distinct voice of each group in its social situation. Additionally, power distribution is important in any study as participants may feel marginalized by the researcher. To combat this influence critical reflexivity is necessary.

Reflexivity acknowledges the relationship between obtaining critical knowledge and the social position of the researcher; as such it will be a crucial part of my study (Campbell, 2004). Reflexivity is an essential tenet in Feminist Standpoint Theory.

Haraway reorganizes Harding's concept of reflexive objectivity in research and uses the term *situated knowledges* which "refers to location, partial, embodiment and partial perspective" (Haraway, 1991, p. 191). She believes in acknowledging partiality and multiplicity of identities more than focusing on the conventional identity categories of race, class, and gender. Haraway (1991) argues that fractured identities may hinder us from obtaining any common discourses. Her idea of a "diffraction" pattern where multiple standpoints are layered upon one another implies "the generation of multiple, displaced images, the overlaying of differently positioned accounts of possible futures as well as possible presents" (Barton, 2001, p. 242). The purpose of diffraction is to understand how reflexivity is used in feminist research (Campbell, 2004). Feminist research seeks stronger objectivity by acknowledging social position and identities.

Preston (1999) argues that values creep into discourses which are considered value-free and one cannot truly find an objective location. I agree that pure objectivity is impossible to obtain. The concept of objectivity in research is one of the most well known basic tenets of feminist epistemology (Antony, 1993; Harding, 1991). Pohlhaus (2002) asserts that all knowledge is informed by interest and "it is only when these interests are made explicit that we can move toward objectivity" (p. 284). Traditional scientific knowledge claims to be value-free, yet it contains androcentric biases and demonstrates what Harding (1991) has called "weak objectivity". By acknowledging and understanding my social location, my research gains "stronger objectivity." Although it is impossible to remove all bias, "stronger objectivity" can be obtained through the use of feminist inquiry rather than traditional empiricism, because of its understanding of social location and beliefs (Harding, 1986; Kourany, 1998).

These tenets of partial and biased views, socially situated knowledge, reflexivity and objectivity are contingent upon one another. Views are accepted as partial and biased if we understand that all knowledge derives from specific social and historical locations. By asserting my social location in research, I add the concept of reflexivity which contributes subjectivity to my research, allowing it to gain stronger objectivity. I agree with Harding (1986), that one cannot speak from entirely a single, sole social location, as such I must acknowledge my locations and the locations of others whom I study.

All women do not belong to one monolithic group where all speak truth with a common voice. We must recognize these differences to gain a better understanding and broaden our view. Yet, I would not go as far as to agree that we are fractured beings with identities that do not contain truth as Haraway and other postmodernists assert. I do not accept the concept of one common discourse for one social location, yet I believe some commonality must exist between ourselves and our experiences for us to obtain any common language and discourse. Some coherence must be present to obtain some way to make sense of our lives and experiences. Postmodernist assert that there are no absolutes, yet this statement is an absolute. The ambiguity of postmodernist positions leaves me bewildered and apathetic. Why study anything at all if everything is relative? I do recognize the value of pluralism and recognizing the diversity of standpoints, yet I assert that it is only through finding some common ground that we can begin to understand our lives together.

As a feminist, I acknowledge my standpoint, and I assert that I should begin my research from the experiences of others as I only hold a “partial view” of what others perceive as reality. Harding (1991) asserts the idea of “starting research” from the lives of

others. By doing so, I am able to better understand the lives of teachers and how they think their beliefs are impacted by their experiences. “Starting research in women's lives leads to socially constructed claims that are less false -less partial and distorted -- than are the (also socially constructed) claims that result if one starts from the lives of men in the dominant groups” (Harding, 1991, p. 185). By starting research from women’s lives, I will ask different questions, gather and analyze data differently, and conduct less partial research than traditional scientific studies.

Feminist Standpoint Theory is a political disruption as it troubles traditional positions of scientific research and the pedagogical practices of science curriculum. My proposed study is political as it aims to disrupt dominant discourses, challenging traditional roles of sex, gender, race, class, and identity construction. I propose to uncover the patriarchal roots of science which covertly pressure teachers and impact decisions they make in the classroom.

#### Critical Race Feminism

Race is a difficult term to define as the word embodies the entangled relationship of race, class and gender (hooks, 2000).

When we remember that women are half of the human race, the poorest citizens on the planet performing approximately two-thirds of the world’s work and earning about one tenth of the world’s income and owning less than one-hundredth of its property, we face more directly the interconnectedness of race, class, and gender. (hooks, 2000, p. 161)

Critical Race Feminism addresses these power issues as it is always concerned with power and who has power (Wing, 2003). Race, just like gender, is always a part of who

we are, what we do, and how others look at us. Thus to an African American student, I am a white teacher. I am labeled by others as female (gender) and white (race). For this reason, I bring Critical Race Feminism into my theoretical framework.

Originally developed as a legal counter-discourse regarding racial oppression in society, CRT provides a determined effort to end oppressive educational and legal structures and attempts to provide a race intervention in the feminist struggle (Cleveland, 2004; Wing, 2003). Feminist research is criticized because it is often blind to the power of whiteness and does not include a conscious understanding of what it means to be White (Maher & Tetreault, 2001; Wing, 2003). Additionally, white women experience life on issues of gender and race as well as women of color. The experiences of white women are unique, just as the experiences of women of color. Thus, it is critical to acknowledge the experiences of all women based on the intersection of their race and gender.

Critical Race Feminists support Critical Race Theory, which they consider a theoretical treasure that addresses hegemonic legal structures and endorses scholarship eliminating the standard White, ivory tower approach (Ladson-Billings, 2005; West, 1994; Wing, 2003). Critical Race Feminism derives features from Critical Legal Studies, Critical Race Theory, and feminist science and philosophy positions.

Critical Race Feminism with its historical and developmental roots in the law, is a multidisciplinary genre based on the need to voice a distinction in the experiences of men of color (which critical race theory tends to focus on) and White women (which feminist theory addresses). (Cleveland, 2004, p. 50)



Feminist Standpoint Theory and Critical Race Feminism both name male domination and power and attempt to combat sexism; however feminist theory does not always embrace issues of race (Cleveland, 2004; Wing, 2003). Critical Race Feminism addresses issues of race in feminist discourse, although many proponents have not joined the ranks of the conventional feminist movement due to their opposition to the idea of essentializing of a common female experience representing the White middle-class woman (Wing, 2003). The core assumption of Critical Race Feminism is that “physical differences among bodies...result in systematic differences in political power” (Wing, 2003, p. 238). This core statement is framed with basic tenets of antiessentialism and intersectionality.

The concept of antiessentialism is to provide an analysis of how race is often invisible in feminist discourse and the essentializing claim of one fundamental female voice which would harmonize in a particular way on a given subject. Wing (2003) asserts, “Critical Race Feminism notes that the essential voice actually describes the reality of many white middle- or upper-class women, while masquerading as representing all women” (p. 7). Essentializing, I believe, is a common practice in education as students are labeled as being a certain way or learning a certain way. However in my research study to avoid essentializing tendencies, I feel it is imperative to bring in Critical Race Feminism.

Critical Race Feminism states that racism is a pervasive social construct and often is invisible in research. “It [racism] is so "enmeshed in the fabric of our social order, it appears both normal and natural to people in this culture" (Ladson-Billings, 1999, p. 12). The concept of intersectionality is a basic tenet as it provides a way to view the

intersection of race and gender. Feminist theory does not adequately address the intersection of race and gender (Wing, 2003). As such it is important to include Critical Race Feminism in my study. I agree that racism is pervasive and insidious, and the combination of racism and sexism provides a unique standpoint for women of all colors. “Women of color are not merely white women *plus* color or men of color *plus* gender” (Wing, 2003, p. 7). The idea of multiplicative identity, developed by Wing, addresses how identities must be multiplied together to equal one identity in determining how discrimination has been used against someone. These intersections for women of all colors do not contradict or favor one aspect over another. For example, being an African American is not counter to being a woman and both identities are considered parts of the whole in identity construction (Cleveland, 2004; Wing, 2003). hooks (2000) asserts that research is silent on issues of class, yet gender, class and race are interconnected and should be addressed.

Critical Race Feminism employs the concepts of antiessentialism and intersectionality to promote the unique voices of women of all colors. In my study, I used a Consciousness- Raising group to raise awareness of the hegemonic nature of science and allow all participants to speak freely without essentializing a monolithic voice. The goal of the group was to observe reactions and feelings of all participants, not to reach a consensus (Morgan & Krueger, 1993; Shreve, 1989).

Other scholars, Delgado and Stefanic (2001), illustrate Critical Race Theory and Critical Race Feminism as important to naming oppression, understanding the power of knowledge, questioning basic premises, and examination of stories used by the dominant group to justify their actions. In an attempt not to be culturally neutral, I assert that

Critical Race Feminism will provide support to my theoretical framework to ensure it is not a culturally neutral, essentializing, “White woman’s study” and it will allow my study to address the race and gender intersection of women of all colors including white.

Alcoff (2000) discusses the notion that whites must acknowledge their White privilege, whiteness, and assume an antiracism stance. hooks (2000) best known as a radical Black feminist, urges all to claim a feminist agenda which includes the voices of women of color. She emphasizes the need for all people to take up a political, feminist agenda to combat racist and sexist biases in society.

Feminist Standpoint Theory and Critical Race Feminism working together both challenge powerful hierarchies constructed on the basis of gender and race. For these reasons, I suggest that a theoretical framework of Feminist Standpoint Theory and Critical Race Feminism would explore the divergent perspectives of female science teachers of all colors. Both theories are important for examination of feelings and experiences as they argue for differing discourses and against dominant discourses. These theories will aid in recounting experiences and thoughts of female science teachers.

#### Harmony of Feminist Standpoint Theory and Critical Race Feminism

One may question the compatibility of Critical Race Feminism and Feminist Standpoint Theory, since Critical Race Feminism finds its roots in Critical Race Theory which rejects objectivity, and Feminist Standpoint Theory seeks to reclaim the term and its underlying concept from long-established science practice. My response to this question is to point out that these two theoretical frameworks are not as far apart as they might seem. Standpoint theory seeks to salvage the term objectivity from traditional science which claims to be value-free and objective. Yet, science contains subjective

biases which are concealed. By identifying these biases, through reflexivity, standpoint theory seeks to strengthen the objectivity of science (Harding, 1991). The “weak objectivity” in science becomes “strong objectivity” by acknowledging the subjectivities that all researchers bring to their research. For example, researchers always impact the questions, data collection, and results, because they start, conduct, and interpret the study from their own understandings. By acknowledging this fact, the objectivity of the study is actually strengthened.

Additionally, as Harding (1991) states, “the logic of standpoint theory requires that the subject of liberatory feminist knowledge must also be the subject of every other liberatory knowledge project” (p. 285). How could I be a feminist and not support all women who struggle against the combined experience of racism and sexism?

Additionally, since race and gender intersect, a theoretical framework addressing both issues is essential to my study. The nature of standpoint theory is to address societal oppression of subjugated groups, to fight oppression, while rejecting the notion of traditional objectivity; as such it is in agreement with Critical Race Feminism.

### Literature Review

This section is a review of the relevant literature on the historical, political, and social implications of science in our society. The “problem of women in science” has been a matter of scholarly research for over twenty years with early work originating from liberal feminist thought (Behringer, 1985; Franz & Stewart, 1994; Gilbert & Calvert, 2003; Harding, 1986; Kahle, 1985; Kourany, 1998). Over the years research has ranged from pursuing equitable science opportunities for women and girls in science (Sadker & Sadker, 1994; Sonnert & Holton, 1995), to altering how science is taught

(Taylor, Frito & Swetman, 1997; Tindall & Hamil, 2004), and finally to the most recent pursuit of understanding the “gendered nature of science” (Gilbert & Calvert, 2003).

For a study concerning the reactions of female science teachers to the hegemonic nature of science, it is essential to review research on the culture of science, teachers, women and the nature of education, teacher attitudes, beliefs and practice, the achievement of girls in science, women’s ways of knowing, and culture and gender.

### *Culture of Science*

The research on the culture of science in the last several decades has called into question the presumed objectivity of science, the masculine construction of science, the gendered nature of science, the exclusion of women in science, and the resulting gender gap.

The presumed objectivity of science is questioned by feminists because science reflects the values of the scientist, so not even strict adherence to the scientific method can ensure objective value-free science. “We feminists of science, are engaged in political contest for meaning, which will work not by replacing one paradigm with another, but by altering the narrative field – a totally different process” (Bleier, 1991, p. 14). Feminist science understands the complexity of science’s social side; seeking to understand human behavior, not strip it from the scientific process (Bleier, 1991). The question of objectivity in science appears in most feminist science research as our culture is embedded in scientific knowledge purported to be objective and truthful (Gilbert & Calvert, 2003; Harding, 1991; Sonnert & Holton, 1995). “Neutrality is believed to be an inherent and defining feature of science” (Bleier, 1991, p. 5). However, scientific knowledge is a social construct which is not neutral or value-free (Gilbert & Calvert,

2003; Harding, 1991; Mayberry & Rees, 1997). Delpit (1995), a critical race theorist and a Black feminist, has explored how the culture of power sets rules and members of that culture may or may not inform others of these rules. In science, the culture of power is that of the White male, thus women and people of color may not be informed of how to successfully participate.

The culture of science presumes objectivity, using a masculine construct that fails to sufficiently situate scientific knowledge (Harding, 1991; Mayberry & Rees, 1997; Sale, 1987). Female entities, like Mother Nature, (the “she” in the natural world) have been objectified and dominated by a male-organized system of science and beliefs (Griffin, 1978; Sale, 1987). Western science is considered a masculine construct as it finds its origin in the seventeenth century when a choice was made to exclude the social structure of science and to pursue a positivist science (Bleier, 1991; Keller, 1985). Science, clothed in the masculine patriarchal society of that time, methodically excluded women and donned the blind eyes of justice as “he” held the balance and scale of equality. During this time, gender constraints were placed on the sexes, King James I warned all against gender crossing, and females were dictated roles of proper behavior (Keller, 1985). This historical patriarchal science should be replaced with new practices, since patriarchies treat women as “the other, [as] something apart, and thus manipulate, use and even despoil them in the name of patriarchy and civilization” (Sale, 1987, p. 302).

The political turmoil of the 1960s and 1970s fueled women’s movements and subsequently feminist movements that begin to question the asserted claim of science’s objectivity and called into question the masculine social construct (Harding, 1991).

International research on gender and science “assumes the problem of gender and science arises in the widespread understanding of science as being largely masculine pursuit which is- therefore – unattractive to women” (Gilbert & Calvert, 2003, p. 862). Children grow up perceiving science as a masculine domain (Sonnert & Holton, 1995; Sadker & Sadker, 1994). Scientific narratives, which historically have excluded women, are increasingly considered by feminists, gendered, socially constructed categories (Keller, 1985; Whitehouse, 2004). As a result, females experience marginalization in science.

Teachers, textbooks, and the hidden curriculum create an environment that contributes to the gender socialization of science (Kahle & Damnjanovic, 1994). Masculinity and rationality underlies the culture of science and defines the boundaries by which boys and girls develop their identities and stereotypic beliefs about science. While primary school science paints a masculine, heteronormative picture for children, “heterogendered boundaries are produced and reproduced with/in school science” (Letts, 2001, p. 261). Children assume their gendered identities in schools and are shaped by a variety of stereotypical roles (Letts, 2001). Goldman-Segall (1996) discusses gender-flexing, as a way for students to step outside their stereotypical roles in schools and particularly in science. Without strategies to allow boundary crossing and elimination of stereotypical beliefs, feminine contributions in science will continue to be underrepresented.

As a result, feminist theorists have studied specific ways which some knowledge has been excluded from scientific thought (Franz & Stewart, 1994). This exclusion has led to an examination of how to better study women’s experiences. Franz and Stewart

(1994) present a set of strategies to aid researchers in their studies of women's lives in relation to science. They differ from other researchers by generating guidelines to learn from the experiences of women in science. They emphasize the "pragmatic value of feminist theory" for those who are writing about women's lives. Their strategies include looking for what is left out in research, analyzing the researcher's position, identifying agency in social constraints, using the concept of gender as an analytical tool, exploring other social positions, such as race, class and sexuality and avoid the search for a unified self. My study framed in both Feminist Standpoint Theory and Critical Race Feminism addresses these guidelines, thus enabling me to view the gendered side of science.

A "gender gap" exists in science and documentation spanning over a decade reveals that this gap is a result of environmental factors (Tindall & Hamil, 2004). These early life experiences have contributed to the gendered nature of traditional science and subsequently the underachievement of females. However, little research has been done on practical changes appropriate to advance the achievement of girls in science and overcome the gender gap (Kahle, 1985). Feminist critiques of science have examined how the nature of science has influenced what questions are asked, who asks the questions, and how the results are being interpreted (Franz & Stewart, 1994; Tindall & Hamil, 2004).

The overall significance of the research in the area of the culture of science has been questioning the presumed objectivity of science, masculine construct of science, and the gendered nature of science and how this all has supported the exclusion of women, with a resulting gender gap in schools and universities. Further research needs to be done which challenges traditional notions of science and explores science experiences



in the classroom. My study will aid teachers in recalling and understanding their personal science experiences and scientific praxis in the classroom.

*Teachers, Women and the Nature of Education*

The present structure of schools is modeled after the patriarchal structure of the family with the father being the head of the household and women carrying out the “routines of domesticity” (Grumet, 1988, p. 86). Grumet (1988) contends that the relationship between teachers and students reiterate the closeness that existed in our childhoods and our parenting. As a result, children enter the classroom bringing with them self-concepts, thoughts, feelings, and beliefs about themselves and their families. The educational dilemma is comprised of more than just textbooks, pedagogy, curriculum and standards. The entire quandary focuses on people and their experiences. Education is not mere. Merriam-Webster defines education as deriving from the Latin word *educere*, meaning to lead out. Grumet (1988) states, “We, women who educate, are the ones that lead the children from first to second nature...to take the child by the hand. When we take them to school, we take them to our father’s house” (p.186).

As we lead them to “our father’s house” Jane Roland Martin (1985) asserts that teachers are sending a patriarchal message of educating for the productive. She contends that teachers are not teaching the caring side of education, such as how to feel and respond. Messages are sent to students which they will carry into their lives and society, as such it is essential to examine the experiences of teachers. Teachers, predominantly female, labor to accommodate the bureaucracy of a patriarchal profession while experiencing oppression on another level (Grumet, 1988). “Because schools both reflect and contribute to the social construction of gender and other cultural norms, so teachers,

as individuals and as colleagues, may be influential in addressing these issues” (Maher & Ward, 2002, p. 74).

To better understand the patriarchal roots and subservient practices of teachers, it is important to look at the history of schooling. In 1794 teaching was predominantly a job for men. It wasn't until 1850 that women joined the educational workforce (McCormick, 2005). Teaching became the opportunity for women to make money and have another career besides mill work. Female teachers now dominate the field with 80 percent of three million U.S. teachers being female (McCormick, 2005). Many see the role of teachers being like the role of mothers as nurturing and instructing. Subsequently, society genderized the job and now commonly places elementary and high school teaching as a female job. According to the Georgia Association of Educators member survey discussed by McCormick (2005) stereotypes represent education as women's work, lack of money in the profession, and lack of respect as three major factors holding men back from pursuing an educational career.

In 1837, Massachusetts established the first state board of education and many of the 13 original states followed suit. Most public school provisions excluded girls and other minorities (Alexander, 2000). Soon after a national system of education was established, the arguments turned to goals of learning and curricular content (Alexander, 2000). During the era of industrialization, women sought employment in schools. Men left the educational field as better and higher paying jobs evolved from the industrial revolution. According to Bernard and Vinovskis (1977), “Teaching served the female job market better than the male market” (p. 333). Women were naturally accepted into the field of education as men left. Due to gender bias, women were considered nurturing and

able to care for children at a lower wage than men. Women were not given control of the schools; instead they were “expected to be the medium through which the laws, rules, language, and order of the father, the principal, and the employer were communicated to the child” (Grumet, 1988, p.85). Raivola (1998) states, “The school has always been controlled by others rather than teachers: by the church until the first half of the nineteenth century, by the social structure for the next hundred years, and by the economy for the past forty years. Servants are not highly respected” (p.366). This lack of control in schools by the matriarch followed the natural order of our culture in the early nineteenth century. The current educational system is a socialized process to support patriarchal and sexist attitudes and practices, and does not seek to resist the status quo (Colazo, 2000; Maher & Ward, 2002).

Historically, males received better educational opportunities and all females, even the ones who became teachers, were denied educational access (Behringer, 1985). “In the case of the sciences, we must conclude that historically women have had only a minor role and, therefore, lower status than men” (p. 24). This inferior role assigned to women is a result of unequal access to a quality education based solely on gender biases. Behringer (1985) cites gender biases of prominent educational psychologists. Stanley Hall (1844 - 1924), a prominent educational psychologist, viewed women as less specialized than men and claimed men had reached a higher evolutionary level than women. Edward Thorndike agreed with Hall on many matters, but differed on the mental capacity of women. After studying thousands of boys and girls he concluded that the difference was too small to be important. However, he held to the belief that men accomplish a higher achievement level based on ability. Patriarchy, sexist, gender-biased

beliefs such as these were held during the 1700s to early 1900s and still continue in less obvious ways today.

As a result, boys were encouraged to attend all levels of school while girls often remained illiterate. Higher education for men included colleges such as Harvard, Yale, Princeton and Columbia which taught higher levels of math, science and languages. By 1969 the distribution of male and female graduate students reveals discrimination by sex and institution (Behringer, 1985). High quality universities held 74% males and 26% female. Medium and low quality universities showed percentages in the 70% for males and 20% for females. Only low quality colleges represented almost an equal distribution with 59% male and 41% female. Inferior schools, lack of educational opportunity, and prejudice attitudes held females back from achieving a level consistent with their abilities.

The educational history of women reveals the lack of opportunity to receive appropriate training and access to full educational experiences (Behringer, 1985; Gornick, 1990). This lack of professional training can be seen in the area of science as most recent as the 1980s with only 29% of Doctorate degrees in science and engineering being awarded to women. Almost one hundred years later, gender bias is reminiscent of women's educational experiences in the 1800s and 1900s. According to the U. S. Dept. of Education, "College programs are highly segregated, with women earning between 75% and 90% of the degrees in education, nursing, home economics, library science, psychology and social work. Women lag behind men in Ph.D.s (40%) and professional degrees (42%), and are the minority at 7 out of 8 Ivy League schools." Weld (2002)

reveals the overwhelming majority of scientists and engineers are men, outnumbering the women six to one.

Changes have been made which attempt to equalize the educational experiences of boys and girls, yet more needs to be done. Discrepancies between the educational experiences of boys and girls are now more covert than they have been historically. Additional research is needed to reveal the hegemonic nature of society, schools, and science and how teachers' experiences have been impacted by these hegemonic structures. My proposed study seeks to unveil this message to science teachers and observe teachers' reactions to the message and their recollection of any lived experiences that surface.

#### *Science Teachers' Attitudes, Beliefs, and Practices*

A review of teachers' attitudes, beliefs and practices is essential as "sexist beliefs are deeply ingrained in our psyches and reinforced in family and institutional arrangements" (Maher & Ward, 2002, p. 11). Lived experiences of teachers, teacher's career choices, their life histories, how their practices impact student success, and biases in the classroom are all fundamental parts of teachers' attitudes and beliefs.

Smith (2005) asserts that relatively few studies have examined how science teachers' lived experiences impacts their pedagogy. Twenty years earlier, Kahle (1985) called for an examination of attitudes and beliefs of educators as essential to science education research as "attitudes of educators may determine both the number and the subsequent success of women in science" (p. 3). Additionally Biklen (1985) asserts that more research should be completed on how gender and educational practices intersect.

Even today more than twenty years later, additional research is still needed on the lived experiences of science teachers and resulting classroom practices.

Biklen (1985) asserts that research which has been completed on “women’s working lives has been inadequate and misleading because it is based on stereotypical assumptions about women” (p. 217). The findings from this study suggest that the prevailing notion of career is not sufficient to explain women's careers as elementary school teachers. The concept of career should reflect the realities and experiences of women's work as well as men's work. We are thus hindered in thinking about the work of women as we are immersed in a society which bases experiences on the white, male norm (Biklen, 1985).

Life histories of science teachers are almost invisible in research. Yet, I found one researcher, Halai who has completed several studies in Pakistan and India. One study completed by Halai (2004) addresses the early lived experiences of teachers. She concluded that early life experiences direct teachers in their beliefs and practices in the classroom. The nature of science teachers’ decisions in the classroom is based on what teachers have experienced in their lives and how they have made sense of those experiences (Halai, 2004). Furthermore, she asserts that when teachers are able to identify experiences from their life they gain insight into their philosophical positions about education, pedagogy, and science (Halai, 2004). In agreement, Argyris and Schon (1980) state, “teachers will use their personal practical knowledge to make decisions about what and how to teach in the class and that the basis for this kind of knowledge is their life history” (p. 28). Improvement in practice will result from critical consciousness of teachers regarding their life experiences (Halai, 2004).

Although few studies address the lived experiences of science teachers, many studies have been completed which address the behavior and attitudes of teachers in science classrooms (Mayberry & Rees, 1997; Sadker & Sadker, 1994; Volman, Eck, & Dam, 1995). The attitudes and beliefs of teachers will determine their practices in the classroom (Maher & Ward, 2002). Subsequently students will define themselves based on the teacher's actions and beliefs becoming a reflection of their teachers' beliefs, referred to often as the self-fulfilling prophecy (Maher & Ward, 2002; Mathews, 1982). Students are the recipients of teachers' actions which are often based on their own individual experiences in society and schools (Ginn & Watters, 1999). As teachers, what we perceive ourselves to be, based on our own experiences and assigned social locations, is what we reflect to others. What students see of themselves in us is what they often will become (Maher & Ward, 2002). Consequently, failing to develop discourses of freedom and counter-hegemonic languages carry heavy consequences for our students and us. It is only after we begin to understand our own perspectives and motivations that we can begin to change our point of reference. It is a laborious process, one that is painstaking and difficult. However, critical consciousness of teachers is needed to name hegemonic practices, thereby empowering others to name bias, prejudice, and silencing behaviors in society and schools. A Critical Consciousness group comprised of female science teachers will aid in our understanding of how teacher will accept the hegemonic nature of science and society and if they will relate their own experiences to this message.

Addressing science pedagogy, Scanlon, Murphy, Thomas, and Whitelegg (2004) assert that the view among science teachers and the general public that science is a body

of objective knowledge derived from facts made from accurate observations and careful experiments that are valid and reliable is misleading and completely erroneous.

There is a “relative lack of knowledge concerning how teachers who do understand the nature of science transform or translate their understandings into classroom practices that impact students” (Lederman, 1995, p. 2). Lederman (1995) studied how teachers’ understanding of the nature of science impacted pedagogy. He found that teachers rarely think about the nature of science when making instructional choices and their objectives significantly impact practice (Lederman, 1995). Argyris and Schon (1980) and Baird (1999) found that through reflection teachers will become more aware of how their pedagogical practices compare to what they actually believe. Lee and Houseal (2003) found self-confidence to be an internal constraint. Additionally, he found that teachers would modify their practice based on self-efficacy and content knowledge. Authoritative and teacher-centered practices indicated low self-efficacy, while high self-efficacy teachers used investigations and student-centered strategies (Lee & Houseal, 2003).

It is necessary to develop teachers’ understanding of their own experiences and the nature of science to aid in their understanding of the connection of personal experiences to classroom practices (Halai, 2004; Lederman, 1995). Teacher biases in the classroom are detrimental to the science achievement of females (Tindall & Hamil, 2004). The science teacher can serve as an agent of societal change or reproduction. However, often teachers’ low expectations contribute to the demise of female science students (Mayberry & Rees, 1997). “Stigmas, labeling, and negative self-fulfilling prophecies related to teacher expectations – all of these practices lead to segregating students by ability. They thus further reinforce expectations that promote the very



negative attitudes and behaviors the teachers are trying to avoid” (Maher & Ward, 2002, p. 32). In the classroom, teachers have been documented as asking males more questions, and providing them more feedback than girls (AAUW, 2002). Additionally, teachers hold higher expectations for boys than girls in science (Tindall & Hamil, 2004). “Girls are praised for being sweet and accommodating, boys for being adventurous and aggressive” (Maher & Ward, 2002, p. 85). Males dominate science classroom discussions and receive more attention from the teacher (Ornstein, 1992; Sadker & Sadker, 1994; Tindall & Hamil, 2004). I propose that most teachers are not aware of their own biased behaviors in the classroom and as Ginn and Watters, (1999) and Halai (2004) assert they are teaching based on their prior experiences in and out of the classroom.

Sadker and Sadker (1994) reveal the most significant and well documented finding in the last 20 years is that teachers interact more and in more detail with boys. According to the American Association of University Women (AAUW, 2002) teachers ask males more questions, more detailed questions with higher-order thinking skills, and provide them with more praise, criticism, and correction, thus giving boys more valuable and detailed remarks. Sadker and Sadker (1994) report that of 1,332 students observed in physical science and chemistry classes, boys spoke more confidently, louder, and more often than girls. Blatant sexism reigns in many science classrooms with teachers talking mainly to boys, allowing boys to solely handle the equipment, and offering praise to mostly males (Sadker & Sadker, 1994). These types of gender biases contribute to the underachievement of females in science. However, one study by Sommers (2000) questioned AAUW and Sadker and Sadker (1994) claiming that data collected in these

studies were full of errors and totally wrong. Sommers (2000) argues that research claiming male privilege is erroneous and declares that boys are suffering in schools. Sadker (2000) responds to Sommers (2000) in a letter printed in *The Atlantic Monthly* countering her arguments by saying that she failed to look at the gender gap in test scores and she has ignored the major findings in his 1994 study and other relevant studies. In my search, her study was the only one of this kind which I found.

Attitudes, beliefs, and practices of teachers have been documented in research as affecting the level of success of students in the classroom. Through their own experiences, teachers will often teach in the way in which they have been taught (Halai, 2004). Often to the demise of female students, science teachers employ practices which oppress female students as this is the way in which they have been taught. “Because of the importance of teacher/student interactions, it is imperative that science teachers do not unwittingly convey perceptions of science as a masculine endeavor” (Matyas, 1985, p. 43). Additional research in this area is needed as literature shows that a connection exists among teachers’ experiences and their current classroom practices and attitudes toward students.

The research on the attitudes, beliefs, and practices of science teachers is significant as it explains the relationship between these factors and student success. Yet, little research has been done on how these attitudes and beliefs have been formed from lived experiences. My study seeks to expose the hegemonic nature of science to middle grades science teachers, observe their reactions to the message, and determine if they will relate experiences from their own lives which would accept or reject the message.

### *Achievement of Females in Science*

Achievement of females in science has been a heavily researched topic in the last twenty-five years (Franz & Stewart, 1994; Matyas, 1985; Sadker & Sadker, 1994). In this section, I will discuss research which centers on females' decline of interest and achievement in science, their need for role models, decline in self-esteem, and the barriers to the achievement of girls in science.

Matyas (1985) asserts girls' achievement and interest in science declines between the ages of nine and fourteen. Girls take fewer science and math courses in high school than their male counterparts. Gender inequity research unveils inequitable pedagogical practices that favor males (Sadker & Sadker, 1994; Tindall & Hamil, 2004), fewer direct and indirect science experiences for females (Sadker & Sadker, 1994) and science as a male construct (Harding, 1991; Franz & Stewart, 1994; Sonnert, 1995) all contribute to low achievement for females. Additionally much concern centers on the lack of motivation and interest of girls in science (Debacker & Nelson, 2000; Goldman-Segall, 1996; Tindall & Hamil, 2004; Volman et al., 1995) and the socio-cultural nature of science which envelopes both educators and students (Harding, 1991; Weld, 1999; Goldman-Segall, 1996; Franz & Stewart, 1994).

To increase the percentage of women in science, factors including educational, sociocultural, and personal must be addressed in research. Educational research conducted by the National Assessment of Educational Progress (NAEP) concludes that achievement, interest, and opportunities to learn science were fewer for girls than boys. Disparities involving the science education of girls and boys exist within the science classroom and within society. Young women fall behind males in science achievement

and self-esteem, thus limiting their options for career choices (Debacker & Nelson, 2000).

With the deficiency of females in science, feminist researchers have expressed a continuing concern for the absence of females in upper level science classes and science career choices (Kahle & Damajanovic, 1997; Tindall & Hamil, 2004; Weld, 1999). Additional, low achievement and interest in science classes leads to fewer females choosing science as a career (Sonnert, 1995). The gap is easily visible as males outnumber females in advanced courses in high school. Recently, female enrollment in science has increased with girls taking more biology and chemistry. Yet, boys still dominate in their enrollment of “physics, calculus, and more advanced courses, and are more likely to take all three core science courses — biology, chemistry, and physics” (AAUW, 1998). When given a choice in high school, females take fewer advanced courses in science (Weld, 2002). Science and technology are documented as one major subject area that exhibits the underachievement of girls (Harding, 1991; Sadker & Sadker, 1994; Weaver et al., 2004).

Role models are needed to encourage girls as sex role stereotyping is one major factor in why girls avoid science careers (Sadker & Sadker, 1994; Sonnert, 1995). Stereotyping of careers creates social pressures and the socialized female role does not include science (Matyas, 1985). “One of the first science role models that girls encounter is their science teacher. Many investigators agree that the importance of the teacher in developing a girls’ attitude toward science cannot be overemphasized” (Matyas, 1985, p. 42).

A decline in girls' self-esteem in science is a topic of many studies. AAWU's survey "Shortchanging Girls, Shortchanging America" (1992) reveals females experience a decline in self-worth and science abilities in middle school years. Sonnert (1995) argues that families' gender-role socialization and early school experiences restrain achievement of girls. Structural barriers bar females from receiving specialized science instruction in schools and instances of counselors directing girls away from pursuing advanced math and science classes have been documented (Sonnert, 1995).

Matyas (1985) uses the term *micro-inequities* to indicate the subtle differential behaviors that indicate inferiority of women and subsequently loss of self-esteem. Maher and Ward (2002) discuss the gender biases of educators in schools, such as lining students up by gender, and separating boys and girls on the playground. These practices may seem trivial to some, but over the course of a lifetime of education, female students suffer with self-doubt and unequal opportunity. External factors, such as family constraints, lack of recognitions (5 of 345 Nobel Prize winners, and only 46 women in the National Academy of Sciences), lower salary, lower status, faculty attitudes and internal constraints, such as low self-confidence, negative self-image, all contribute to the disparity of girls in science. Research on classroom pedagogies starting in kindergarten through college reveals that girls of all ages and ethnicities do not receive an education equal to males (Maher & Ward, 2002). Experiencing loss of self-esteem and becoming silent in the classroom, females enter school ahead and exit school lagging behind their male counterparts on standardized test scores (Ornstein, 1994; Sadker & Sadker, 1994; Tindall & Hamil, 2004). This is not due to inferior intelligence of girls, but is partially due to girls supporting the belief that boys know more in science than they do. This lack

of confidence continues past school years as “Science is still perceived as a masculine endeavor, and even highly-qualified female graduate students in science must face faculty and fellow students who double their dedication and ability” (Matyas, 1985, p. 97).

Many barriers exist to the achievement of girls in science. The nature of science and its organization are two barriers which greatly add to the underachievement of females (Harding, 1991; Sonnert, 1995). Social and political burdens inhibit women in science along with their negative views of successful science experiences (Debacker & Nelson, 2000). Additionally, stereotypical perceptions of science as a male domain and lack of confidence in female students add to obstacles females must face (Debacker & Nelson, 2000; Hammrich, Richardson, & Livingston, 2000; Sonnert, 1995). Science instruction does not accommodate varied learning styles; instead it promotes competition and gender disparity (Sadker & Sadker, 1994; Tindall & Hamil, 2004; Weld, 1999). Volman and colleagues (1995) call for additional research on gendered identities to better address underachievement of girls in science. Additionally they argue that research focusing on girls as the problem has led to girls being treated as objects. “By starting from the assumption that girls are a problem, researchers have been led into looking at them as an object” (p. 291). This objectification of girls has created a self-perception as being unable to perform as well as boys in science, and many times when they have the ability girls hide it out of fear of ridicule (Debacker & Nelson, 2000).

Research shows that males and females do not significantly differ on their perceptions of science in grades five through seven, however gender differences in perceived ability in science emerges after age twelve (Gilbert, 1996). “Perceiving science as a male domain can serve to decrease motivation to learn” (Tindall & Hamil,

2004, p. 8). When girls are successful in science, research shows that girls and teachers attribute the success of girls to their effort and not to their ability (Gilbert, 1996). Other studies, (Ryckman & Peckman, 2001; Taylor et al., 1997) support girls attributing their successes to effort while they believe successes of boys are due to ability. As a result, learned helplessness, hopelessness and even emotional disengaging are all attributes of girls in society, schools, and science (Franz & Stewart, 2001; Ryckman & Peckman, 2001).

Sonnert and Holton (1995) argue that women are less likely to succeed in science because of the deficit model and the difference model. They asset the “deficit model” for women which illustrates that women have fewer chances then men in their careers and “they collectively have worse career outcomes” (p. 2). This model represents how women are treated differently in science, while the difference model represents how women act differently in science. Although formal barriers to women’s entry into science were outlawed in the 1970s, subtle barriers still exist. Women scientists are socially isolated, have less access to resources, and receive less recognition (Sonnert, 1995). These barriers affect current female scientists and inhibit females from choosing science as a career. Gender-role socialization for men to be aggressive and women to be nurturing and supportive, discourage girls from a young age to strive for achievement based on competition and aggressiveness (Sadker & Sadker, 1994; Sonnert, 1995). Harding (1991) calls for a revolutionary change in the foundation of science and the culture surrounding it to incorporate more female traits and characteristics.

Educational, sociocultural, and personal factors must be further addressed in research to determine the cause of gender disparity in science. Further research is needed

on how to break down formal and informal barriers which discourage females in science. Requiring females to fit in the scientific mold constructed by and for males is a hegemonic strategy which deters females from science. Further research is needed on how females experience their world and how their world can influence scientific knowledge. My proposed study seeks to reveal the hegemonic nature of science and to collect teachers' responses and experiences relating to their message. This type of study involves how women know their world and how they interpret their experiences.

### *Women's Ways of Knowing*

“In order to dominate, the dominator has no choice but to deny true praxis to the people, deny them the right to say their own word and think their own thoughts” (Freire, 2001, p. 126). The theme of silence is a persistent theme in research on girls and women (Belenky, Clinchy, Goldberger, & Tarule, 1997; Gilligan, & Sullivan, 1995; Iglesias & Cormier, 2002, Taylor et al., 1997). True praxis requires reflection and action directed at what needs to be changed. However, Iglesias and Cormier (2002) found that by late adolescence girls become disconnected and disassociated from themselves with no self-actualization of their silence. Often these girls become female teachers who have bought into their domination, lacking their own voice and thoughts to name their plight. Knowledge is not just accepting or changing a belief system. It inherently requires a relationship between the “knower and the known” (Harding, 2004, p. 361). Thus, a study of thoughts and experiences and how they understand these experiences is vital in curriculum studies. Ritchie and Wilson (2000) assert “when teachers can consciously locate the sites of their resistance to prescriptive ideologies of personal and professional identity, they have the possibility of intervening in them and contesting them” (p. 14).



Females concern themselves with relationships and lived experiences and define their identity in the context of a caring relationship, but male self-descriptions center on individual achievement (Gilligan, 1982). Consequently “intimacy goes along with identity, as a female comes to know herself as she is known, through her relationships with others” (p. 12). Women perceive life as a “web” rather than a “succession” of relationships. A lack of language for females to describe their care and connection impedes interpretation of their experience and the experiences are “dissolved by the hierarchical ordering of relationships” (p. 49). Questions are raised as personal doubts undermine their sense of self and ability. With the norm being White male behavior, the differences found in women are not construed as only different, but found as inferior because of the single scale of measurement. “When women do not conform to the standards of psychological expectations, the conclusion has generally been that something is wrong with the women” (p. 14).

My study is centered on exposing the hegemonic nature of science and how teachers respond to this message and recall their own experiences. Therefore, their understanding of personal experiences and how they have come to know what they know is crucial. Ritchie and Wilson (2000) assert that teachers’ experiences are not critically analyzed and most do not understand how their experiences are constructed or impact their current practices. To address these different ways of knowing, Belenky, Clinchy, Goldberg, and Tarule, (1997) outline five ways of knowing as silence, received, subjective, procedural, and constructed knowledge. He characterizes silent women as having no voice, not being able to express their thoughts to others. Receivers are women who obtain information from others upon who they rely as the authority. They do not see

themselves as having power, but receive the power of knowledge from others. Subjective knowers are oppositional to receivers as they do not trust others, but only trust in what they know for themselves. “Subjectivist women distrust logic, analysis, abstraction, and even language itself” (Belenky et al., 1997, p. 71). They “deny strategies of knowing that they perceived as belonging to the masculine world” (p. 71). Procedural knowers obtain their knowledge from the rationality of authorities and do not rely on personal perceptions. Women who construct knowledge assimilate procedural and subjective knowledge to create meaning from experiences. Understanding a female teacher’s ways of knowing is necessary in understanding how she interprets experiences.

Women’s negative attitudes toward scientific abstractions are usually founded in a concrete experience with a teacher, doctor, or male from the past (Belenky et al., 1997). High schools and college are filled with male science teachers although over half the students are female (Belenky et al., 1997). These teachers most often are considered the experts not to be questioned. Often students perceive that scientific theories are absolute truth not to be questioned, but only consumed. The feminine voice is quieted with the god-like knowledge portrayed by man in a science classroom. Silent women fear they will be punished for using words (Belenky et al., 1997). However, when women speak up and are questioned regarding these theories they see them as simple models, subjective, not objective truth (Belenky et al., 1997). These “modes of thought cultivated by women have had relatively little impact on the values and directions of modern day society” (Belenky et al., 1997, p.72).

Addressing the nature of science and the genderization of science has been a concern in recent research to improve the achievement and self-image of females.

Debacker and Nelson (2000) found that employing strategies to improve motivational interest of girls in science would likely lead to an increased achievement level and more likelihood of continuing in upper level science classes. Feminists call for connecting science to the natural world, valuing intuition, insight, and intimacy to exemplify a feminine language of science (Tindall & Hamil, 2004). Clearly it can be seen that by simply teaching all students using the same methods will not automatically lead to equitable outcomes for all (Kahle & Damnjanovic, 1994).

Gilbert and Calvert (2003) argue against research that aims to remove barriers or close gaps. They assert that women are not receiving their full rights, yet they disagree with research to remove barriers. Instead, they promote using a narrative approach to develop identities and language in science. Rejecting the notion of the “problem of women and science,” they believe stories based on experiences create or constrain individuals and become the framework in constructing identities and relationships. Narratives in science education provide a way to engage young women in science (Gilbert & Calvert, 2003). Whitehouse (2004) and Goldman-Segall (1995) call for narratives as an effective strategy to change perceptions of science and found that using student narratives from real world experiences engaged girls in the science classroom.

Women’s ways of knowing their world center on the ideas of females being able to form caring relationships (Gilligan, 1982), break through the silence (Belenky et al., 1997), name their oppression (Freire, 2001), and speak in narratives (Gilbert & Calvert, 2003; Whitehouse, 2004; Goldman-Segall, 1995). The use of these strategies seems to invite success of female teachers and students in science classrooms, but more importantly empowers females to unshackle the oppression of societal norms.

## *Culture and Gender*

“Women’s lives are socio-culturally determined...each woman’s story can become every woman’s story” (Bizzari, 1998, p. 113). Although, I don’t agree that there exists a monolithic feminine voice, I do believe that female experiences in our culture have similarities. It is important to address how cultural beliefs are embedded in self-definitions in the lives of women, how these beliefs lead to powerlessness and loss of voice, and a sacrifice of personal goals.

Women and men develop “gendered selves which lead to making certain choices often resulting in unequal opportunities and experiences” (Bern, 1993, p. 112). Subsequently, women are assigned inferior roles in society due to their gender (Matyas, 1985). Women are often defined by others based on their capabilities and their gendered identity (Bern, 1993; Smulyan, 2000). “Gender is a powerful dynamic” in the lived experiences of females (Smulyan, 2000, p. 590). Due to their gender, women are often silenced, which inhibits thought and action and promotes quiet submission. “Anesthetize the people so they will not think” (Freire, 2001, p. 149). Females are objectified and lose human qualities and their subjugation is more easily brought about. Females are molded by their “invaders”, thus characterized by society to assume their inferior roles (Freire, 2001).

Feminist theorists have aided our understanding of powerlessness in society (Franz & Stewart, 1994). “Depriving women of the right to feel good about their intelligence, abilities, achievements, opportunities, responsibilities, basic needs, education, and work make them feel and appear powerless as women” (Bizzari, 1998, p. 112). By studying women’s lives we gain a deeper understanding of their experiences and

how their experiences impact their identity and perceptions of their place in society. Loss of feminine voice has been a major area of feminist scholarship (Belenky et al., 1997; Iglesias & Cormier, 2002; Sadker & Sadker, 1994; Taylor, Gilligan & Sullivan, 1995). The feminine voice “has the capacity to carve out a different approach in intellectual life” (Gornick, 1990, p. 145). Silenced voices and loss of desires have been a result of females denying themselves their full potential, and the working selves of females have been left unexplored (Gornick, 1990).

In addition to inferior and powerless social locations women sacrifice personal goals for the sake of family resulting in lost opportunities (Bizzari, 1998). Career aspirations are often constrained, constricted, and confined to societal norms funneling women into traditional female careers, teaching, nursing, and other service jobs (Bizzari, 1998). Social-cultural expectations define women’s work (Bizzari, 1998; Taylor et al., 1995). Women, considered the “other”, the negative of the male discourse, need escape from their molded position (Pinar & Reynolds, 1992).

My study aims to release the voices of women by allowing them to speak freely and openly about their understanding of the nature of science, their gender and their experiences. The Consciousness- Raising group will provide a safe place to share with others and construct meaning to beliefs and experiences (Shreve, 1989).

## CHAPTER 3

### METHODOLOGY

The methodology of my study refers to the organizing principles guiding the collection of reactions and reflections of female science teachers in a Consciousness-Raising focus group. I studied the reactions and reflections of female science teachers to a video entitled "Asking Different Questions: Women in Science" (1993). This video discusses the value-laden nature of science and why the questions that female scientists and engineers ask are different from those asked by the majority of male scientists. After the teachers viewed the video I recorded how the teachers in the focus group reacted to the message that science is value-laden and how they connected this message to their own experiences. This type of research is considered feminist experiential research, which stresses individual experiences, thoughts, and standpoints (Wilkinson, 2001). Feminist experiential research finds its roots in Standpoint Theory and often uses focus groups for data collection (Wilkinson, 2001). C-R focus groups allow women an opportunity to deconstruct the masculine nature of our society and reconstruct it through a feminine lens as "commonality produces confidence" (Donovan, 1985). As such, my methodology harmonizes with my theoretical framework of Feminist Standpoint Theory and Critical Race Feminism as both these theories rely greatly on critiquing experiences and challenging dominant discourses in society.

The objective of this study is to record the reactions of middle grades, female science teachers to the message that science is a patriarchal, hegemonic, social structure. Furthermore, the teachers were asked to share lived experiences and their perceptions of these experiences that surfaced during the video. Surrounding ourselves with stories from

past and present experiences allows us a starting place, a place from which to begin with a new understanding as “the way we know has powerful implications for the way we live, and vice versa” (Conle, 1999, p. 13).

As a curriculum studies researcher, I seek to acquire a deeper understanding of teachers’ thoughts and experiences, hoping to gain a better understanding of my own. Gay (2004) and Pinar (2004) discuss the importance of self-knowledge and reflection by teachers and researchers to aid in their research of pedagogical beliefs. I acknowledge that my world view is influenced by my personal theories and impact how I understand the lives of others. Studying the reactions and thoughts of teachers, will allow me to further my understanding of science teachers and how they understand the nature of science.

Potential participants for my study were located by using a snowballing procedure to find women science teachers. I used my personal contacts to spread the word of my study by telling others in my community about my dissertation topic to solicit responses from women who would be interested in being screened as potential participants. I protected my study by ensuring that my potential participants were teachers whom I have not met or only have made their acquaintance. The participants were not friends or other teachers with whom I work. My friends and I contacted other teachers regarding their interest in my study. We requested that interested teachers contact me on my home email. When someone emailed me expressing an interest in my study, I emailed the Screening Survey consisting of three short questions regarding teaching experience and beliefs. Teachers who returned the completed survey and had three years experience teaching science in middle grades were contacted by phone to confirm their interest in

participating in the study. I asked each one if she were willing to watch a short movie that presents one idea of the nature of science and share reactions in a small focus group comprised of middle grades female science teachers.

Based on the screening procedures, I choose eight teachers for the study. This sample size is indicative of Consciousness-Raising focus groups used in qualitative research as it is not meant to be a representation of all science teachers, but the perspectives of just a few (Rabinowitz & Martin, 2001).

The C-R group met in an impartial, yet comfortable, location. It took place in the home of another female teacher who was not participating in the study. Once the members arrived, they had casual, unstructured open time to chat with the other participants and me. This time allowed the participants to become better acquainted with the other focus group members and comfortable with the environment. Next, I began by allowing participants time to introduce themselves in the group, and I introduced myself and outlined the events planned for the evening. The group members were invited to discuss their views on science teaching. Next, we watched the video, and then each teacher was invited to share her reaction to the video and any memory of experiences that may have surfaced as a result of watching the video. I ensured confidentiality for all participants by using pseudonyms for teachers' names and their schools. Additionally, participants are protected by fictionalizing the sites where their experiences occurred and by writing their reflection in a novel-narrative style.

The group was invited to reconvene in one week for an optional meeting. I encouraged all the participants to think about the message in the video and share any



thoughts with the group members and me when we met again. No one found it necessary to meet with me the following week, but a few emailed several additional comments.

### Consciousness-Raising Groups

Consciousness-Raising groups were first used in the 1970s to challenge gender roles and sociopolitical structures through the sharing of personal experiences in small groups of women (Biaggio, 2002; Unger, 2001). Today feminist therapists and researchers often form groups of women to build relationships, raise awareness, and name issues that silence and oppress women (Biaggio, 2002; Rabinowitz & Martin, 2001). This innovative method has been credited with using a naturalistic, social context environment with real-life interactions where women construct meaning together (Rabinowitz & Martin, 2001).

Consciousness-Raising has a foundation of raising awareness of hegemonic experiences and enables us to view the world through the eyes of another. C-R groups heighten critical awareness of domination and hegemonic practices which occur in our lives personally and corporately. C-R groups allow participants to hear others and this often cues them in to their own feelings and experiences which they may not have been able to verbalize or identify (Morgan, 1993). The participants may “become aware of things they have not thought of before” (Morgan, 1993, p. 17). Feminist methodology has a “political agenda of finding ways to better understand women’s lives –our own, those of the participants, and the relationship between the two” (Bloom, 1998, p.41).

I assert that a feminist methodology of a Consciousness-Raising Group is the most appropriate for this study. This type of feminist research releases the voices of those

most often marginalized and challenges traditional modes of power. A C-R group allows women to self-reflect and helps each one to explore her identity and self (Unger, 2001). In my study, a Consciousness-Raising group of middle grade teachers allowed spaces for female teachers to critically reflect on the nature of science and their own lived experiences. Smith (2005) asserts teachers' lived experiences in and out-of school contexts "shape teachers' beliefs about the nature of a field of study and what it means to teach and to learn within that discipline" (p. 7). hooks (1981) and Delgado and Stefaniec (2001) all discuss the importance of stories in examining past experiences and understanding oppressive social structures. Stories from individuals who are subjugated reveal hegemonic relationships (Harding, 1991). Experiential stories, power, and knowledge organizations in society, need to be deconstructed in science education (Harding, 1986) particularly in the lives of teachers.

By revealing the hegemonic nature of science to a C-R group, I assert that teachers, who once considered their science experiences to be objective, will become more conscious to the reality of subjective influences in their lives. "Because knowledge will always be informed by particular interest and desires, it is only when these interest are made explicit that we can move toward objectivity" (Pohlhaus, 2002, p. 284). Personal knowledge, which we all acquire through experiences, is constructed through dominant discourses. When we begin to understand that our knowledge has been informed by others, we move closer to understanding that our decisions are not objective, that our lives are influenced by the subjectivities of society.

## Data Collection and Analysis

My data collection focused on what female science teachers in the focus group believed about the masculine hegemonic nature of science prior to watching the video. Each teacher received a short pre-test prior to the focus group activity. This pre-test is shown as Appendix D, Opinions Prior to C-R Experience, and served as a pre-test and a post-test. During the focus group meeting, I audio recorded discussions before the video and then again after the teachers had watched the video. I completed field notes to observe and record their responses to the message that science is not an objective, value-free construct. In agreement with feminist methodologies, the reactions and stories of the participants guided the conversation (Bloom, 1998). Attention was given to identifying how teachers relate their own personal experiences to the message in the video. Black feminists call for a narrative response to emphasize meaning (hooks, 2000). This type of questioning was crucial in aligning my methodology with principles of Feminist Standpoint Theory and Critical Race Feminism.

The data analysis began immediately after the focus group adjourned. I completed summary comments, notes, and observations. Next, I summarized the group's discussion and worked on finishing any field notes from the evening. I kept the research questions in mind as I recalled specific themes which emerged during the discussion. The tapes were transcribed as soon as possible, and I used a data analysis instrument, Appendix E, Data Analysis Spreadsheet, to allow the emergent themes and patterns to emerge. The spreadsheet was a live document, changing as needed. "Data analysis within an experiential framework appears more akin to art than science" (Wilkinson, 2001, p. 21). I used different colored highlighters on the transcript to identify units of information that

became the defining features of the categories. This included direct quotes and summary statements. These colored texts were then cut out and separated into piles that developed into the categories to help define salient themes. As the text was coded and separated into piles, the originally categories were constantly compared with the new code being incorporated. New categories were defined as needed and original ones were broadened. The purpose of the coding was to organize the data from transcriptions in a way that assisted interpretation and answered the research questions.

Of paramount importance in my study was the concept that all participants had their own voices, and I emphasized that a group consensus was not needed. My participants had “open and unrestricted opportunity to respond” and I did “take seriously as data the words of the researched” (Rabinowitz & Martin, 2001, p. 37).

Feminist methodologies are concerned with power relationships in research. C-R groups are credited with disrupting the traditional power relationships in the research study and giving more control to the participants (Jowett & O’Toole, 2006). “The goal for feminists is to understand power’s complexities and its influences on how we interact with each other” (Bloom, 1998, p. 40). As such, it is important for me to discern power relationships, then analyze and name them as they surface in the data collection process (Bloom, 1998). Participants were able to voice their thoughts as a group and individually without fear of trying to respond to the researcher with what they believed I wanted to hear. I stressed to the group that a group consensus was not needed, and I there were no right or wrong answers. Jowett and O’Toole (2006) state that the power relationship between the researcher and researched is disrupted by the strength of the group. Group consensus can be a problem in C-R focus groups as the sense of community is built

(Jowett & O'Toole, 2006). However, Morgan & Krueger (1993) state that this potential problem can be dispelled by pointing out to the participants that as a researcher you desire a variety of responses and not a group consensus.

I had a mutual working relationship with my participants during our time together. Maintaining an informal atmosphere is one key in focus groups to reduce tension and encourage all to share experiences and opinions (Jowett & O'Toole, 2006). I did not fit their responses into categorical forms, but allowed them to flow into full discourse of stories free from constraints of traditional interviews (Bruner, 1990; Ritchie & Wilson, 2000). Standpoint epistemology is a social theory as the social location of the knower is vital to the research process of understanding experiences. Knowledge is gained through an engaged, interested struggle “to understand one’s experience through a critical stance on the social order within which knowledge is produced” (Pohlhaus, 2002, p. 285). Harding argues that Feminist Standpoint Theory is compatible with research on women’s diverse experiences and their standpoints must be forged as naming a standpoint is not just mere recording of experiences (Harding, 1987).

In my research I acknowledge my own positionality and how it may influence my work. “Feminist methodology’s challenge to researchers [is] to put themselves on the same critical plane as their research respondents” (Bloom, 1998, p. 53). By addressing my own social locations and beliefs as a feminist, science teacher, I add to the objectivity of my work and attempt to diminish the power relationship which can exist in data collection.

Reflexivity was used during the entire research process as it is necessary in a feminist standpoint theoretical framework (Bloom, 1998; Harding, 1986). Reflexivity is a

self-scrutiny that controls method (Lyon & Conway, 1995). Rabinowitz & Martin (2001) define reflexivity as a “consciousness of the relationship of the research to the researched” (p. 37). It reminds us of the value-laden nature of research and analysis of data and exposes the subjectivities of the researcher (Rabinowitz & Martin, 2001; Lyon & Conway, 1995).

Differences are based on relations, so my ability to understand another’s standpoint is based on my willingness to critically examine myself (Moya & Hames-Garcia, 2000). The relationship of the participants to me was important to my research as it became part of the research, and I cannot separate myself from what I see in others (Wilkinson, 2001). Since Feminist Standpoint Theory starts with the experience of women’s lives and is described from the standpoint of women, the interest of the research becomes part of the evidence. As we observe the world we change it (Lyon & Conway, 1995). “The beliefs and behaviors of the researcher are part of the empirical evidence for (or against) the claims advanced in the results of research” (Harding, 1987, p. 9). Harding (1987) claims that this “subjective” element increases the objectivity of and decreases the “objectivism” which is usually not openly acknowledged. According to Glesne (2006), reflexivity obligates me to conduct two research projects simultaneously; one study will be on reactions and experiences of female science teachers to a video and the other will be a study of “myself.” “Objectivity is traditionally attributed to knowledge that appears to come from a value neutral and non-situated position. On the standpoint account, however, all knowledge is situated and grows out of particular human interest” (Pohlhaus, 2002, p. 284). My interest to expose the hegemonic nature of science is stated up front in my study.

## Conclusion

Feminist Standpoint Theory attempts to change epistemological constructions in science with a social goal of improving the lives of others. Critical Race Feminism addresses the intersectionality of race and gender and questions the essentializing tendency in feminist research. These theories attempt to open our minds and eyes to knowledge which is persistently hidden, erased, or ignored. Furthermore, they provide a framework in scholarship to bring positive change to the lives of others by revealing hegemonic structures which have been subtly hidden and unknowingly accepted by others. This study is educationally significant as we are able to unveil the hegemonic nature of science to a Consciousness-Raising group of female science teachers and record any connection they may make between these experiences and their beliefs about the patriarchal structure of the nature of science. What happens in schools and specifically in science classrooms impacts future generations of learners and their beliefs about society and the roles of gender in society and science. In addition, it is important for female teachers to critically examine the nature of science, their lived experiences, and how these experiences influence their beliefs.

## CHAPTER 4

### REVEALING REACTIONS AND REFLECTIONS

The evening sun started to hang low in the sky as the first teacher arrived to meet with the other participants and myself for an evening of science discovery. She knew little else except to relax and express her opinions freely. A teacher not in the study offered her home as a place for us to meet. Her house served as the perfect location to create a comfortable backdrop. I was glad to be hosting my focus group away from any location which may inhibit true reactions and reflections. The manicured lawn and brick entrance with flower pots served as a welcome to our informal meeting.

I peered from behind the curtains, as the first participant nervously shuffled up the sidewalk onto the porch. Andrea (all participants have a fictitious name for their protection) a beautiful 40 year old, dark skinned Italian who brought not only her heritage where her grandparents were interpreters on Ellis Island, but also the 18 years of middle grades science teaching experience. As a mother of three, one six year old boy, one nine year old boy, and a thirteen year old girl, she understood the powerful influences of males in society. She was beautifully dressed in casual spring colored crop pants and feminine sandals.

Like each of the eight participants, Andrea came with an interesting and unique background bringing her distinctive views on the topic of science. As Andrea entered the large foyer I introduced myself and she smiled broadly and seemed a bit relieved. The doorbell rang again and we both stepped aside, so Deanna could join us in the foyer. She reached toward me with a friendly, yet firmly grasped handshake apparently at ease with herself and us. Dressed in jeans and an oxford buttoned shirt, she confidently introduced



herself asking for my name. Deanna brought with her a distinguishing background of 17 years of teaching science in New England, Southern, and Pacific Coastal states. She joined our group not only as an experienced science teacher, but a former pre-medical student with extensive science training. Deanna is 49 years old and married with a 20 year old son and a 23 year old daughter. Her mannerisms, style, haircut, and dress appeared more masculine than any of the others.

I led the way into the kitchen and introduced my first two participants to our hostess, Maggie. Friendly and naturally outgoing, she initiated an intense conversation concerning shoe styles with Deanna and Andrea. I was relieved to see them occupied as the doorbell rang again. I answered it and Katie, a tall, slender, quiet-mannered woman, asked if she had the correct house. Her soft mannerism were apparent immediately, but her firm and confident tones were evident later in the evening, as she let the focus group know that she understood the plights of those most often marginalized in schools. Later the group learned that she was 48 years old, a mother of two teenage girls, and brought to the group a matchless vantage point of being a science teacher and having acquired 18 years of special education experience. Throughout the night, I noted that she did not speak as often as many of others, but spoke boldly and with fervor when she did share her thoughts.

As Katie and I stood in the foyer chatting briefly, Hannah appeared in the doorway with a broad smile and cheerful laugh. She didn't seem to be as apprehensive as the others, but more energized and excited about the evening. I escorted the two into the larger group gathering in the kitchen around the snack table and we soon learned that Hannah is 41, married, and a mother of a 10 year old girl, and a 12 year old boy. She

eagerly shared that she works part time as a teacher, but also volunteers in schools near her home as a mentor for students struggling in reading and math. She has nine years experience teaching science, math, and reading in grades four and five. By her willingness to share so much, so soon, in such a thrilled manner, I thought she was looking for a fun time of camaraderie with the group.

The dog barked as the door bell rang once again, and I hurried to meet my next two participants. Another soft-spoken, beautiful dark-skinned Italian dressed very fashionably and tastefully flashed a conservative, yet friendly smile when I open the door. I introduced myself and soon learned her name was Erin. She was 48 years old with 21 years of experience teaching science in fourth through sixth grades. Her demeanor was professional, yet friendly. Later in the evening she shared with the group that she is married with two children, an eleven year old boy and a fourteen year old girl. She was sociable, yet reserved, and genuinely concerned about the nature of schools and science. Addie stood beside Erin on the porch both surprised to see each other at the same meeting. The two had worked together many years ago and were pleased to have met up again. Addie joined the women who had seated themselves in the den, a comfortable large room with leather sofas and comfy pillows and rugs everywhere. Gliding easily onto the leather sofa, Addie seemingly was a little nervous with the group. Wearing jeans and a light blue, pull over shirt, she introduced herself to the others as a fifth grade teacher with six years experience. She shared that she was thirty-five, single, with no children of her own, but happily spent time with her three nieces. She briefly shared how tough her school year had been because of inclusion problems and administration difficulties and was trying to decide whether to remain in teaching or not. Erin sat nearby

perceptibly aware of Addie's uneasiness. The group encouraged Addie to stay in teaching, reminding her that some years are tougher than others.

Ellie arrived soon after Addie and joined in comfortably with the group. The youngest of all the teachers, Ellie is only 32 years old. She sat down on the floor next to the sofa and slipped off her shoes. She seemed relaxed and confident as she shared her four years experience teaching science in grades four and five. Ellie is married and a mother of a five year old girl and a six month old boy. Ellie brought excellent insight to the group as she compared her schooling experiences to that of her brothers.

The teachers had time to mingle and become acquainted, as our last participant arrived. Mary, a white, female teacher with five years of science teaching experience in fifth and sixth grades, is also a mother of a female, third grader. Mary introduced herself as soon as she arrived and said that she would need to leave early. I told her that would be fine just to leave whenever she felt she needed to go. Mary began to explain that she needed to be home with her daughter the night before the high-stakes Georgia Criterion Referenced Competency Test. Her daughter was nervous about passing the test because of the pass/fail standard for third graders. She stayed for the first part of the discussion, nodding her head occasionally to the comments of others. She watched about half the video and then left. I wondered how much her apparent nervousness about the test transferred to her young daughter. Did her daughter feel incompetent because of her mother's own fears? She left too soon for me to really understand her viewpoints.

Fifteen minutes or so passed quickly as we all informally chatted, while most of the women returned to the kitchen briefly to enjoy the delicious snacks. Everyone became acquainted quite easily. Soon, the group settled in the den area once again with

their snacks to begin our conversation before watching the video. A few women had already claimed comfortable spots on the oversized leather furniture. The audio recorder was turned on as conversations and laughter could be heard in the background. The first discussion was prompted with the guiding questions centered on the nature of science. The room briefly fell silent as each teacher began to ponder the nature of science. Andrea started the conversation by explaining how she teaches science.

“I’ve found that there are more teachable moments in science than in any other subject. I get on CNN and find anything that I can bring to the classroom the next day,” Andrea said as she looked about the room for other comments. Many others shook their heads in agreement still appearing a little baffled over the term “nature of science.” Finally the awkward silence was broken as Deanna began to explain that she understood science as a form of training, and with more training we would all understand that science was objective. She explained that her pre-medical classes in pre-med school, prior to her education training, afforded her the opportunity to take many science classes that most teachers normally are not required to take. It is within the context of this schooling that she grounded her thoughts and views that science is objective and value-free. She argued that as long as science is “set up” following all the rules of formal science training that it is totally objective. “The scientific method is the nature of science,” she contended, and with more formal science training we’d all understand the objectivity of science.”

Katie quickly began a rebuttal to Deanna’s idea of the true objectivity of science. She strongly disputed, “Science may be objective in your realm of thinking. It may be totally subjective to me because I may be thinking of it in a very different form. I think it

can be subjective because I can look at it from a different viewpoint. So in some ways I think it can be subjective.”

Deanna seemed a little irritated and retorted back,

Actually, if you are trained in it, then the subjectivity is eliminated a lot more. I’m not saying that it is completely zeroed out, but if you are actually trained in it then it is eliminated a lot more. Where you find the subjectivity coming in is where you find people who really have not had the background in science. What you are able to do is to step back and show the students a bigger picture. I’m not meaning the more science that you teach, but the more science training that you’ve had. Because you teach the same thing over and over again, but if you have taken a lot of science classes and courses and been in the scientific community as a scientist you understand that it is objective.

Katie calmly points out to Deanna, “Aren’t you being influenced by what has been presented to you instead of you going out and discovering your own?”

The bantering continued between the two educators as Deanna replied, “But you see it’s not a matter of discovering your own. It’s kind of like math in the same sense, like math is  $2 + 2 = 3$ ? No.  $2 + 2 = 4$ . I’m serious. Think about how many science courses you take and we have all these hands-on things and the kids learn this stuff and then what do they do?”

At this point, Katie had no reply. Appearing to be somewhat frustrated with the conversation, she seemed to have given up in convincing Deanna that science contained subjectivities that she brought to it from her own perspective. I sat on the floor next to Katie thinking to myself, “How does she understand the subjectivities of research and

science before she has even watched the video?” Later when I questioned how she understood so much prior to the video, she shared with me that her special education background allowed her to see the prejudices in schools and society. Additionally, as a female science teacher and a mother of two teenage girls, she had experienced and witnessed the power struggles that occur in the classrooms and in society as a whole.

After the conversation between Katie and Deanna settled and the tension in the room disappeared, Hannah spoke up and shared that she had never really thought about the nature of science, but considered herself an objective science teacher because she relied totally on the book. At this point, others freely acknowledged that they had not thought of the nature of science in the past. These findings are supported in research by Lederman (1995) which states that teachers rarely think about the nature of science especially when they are planning what to teach.

“I’m not a very good science teacher because I’ve not had any additional training,” Hannah claims. Her expertise is in teaching early intervention reading programs. She shares,

I didn’t care for it [science], because of that I am a very objective teacher. But as far as being objective, I picked and chose what I taught, how I taught it, what the standards were, and I did exactly what the standards were. You (pointing to Deanna) gave them much more because you loved it. You gave them all of this and I gave them this (motioning her hands to a smaller circle).

Deanna seemed a bit shocked as Hannah shared her comments. She didn’t speak for a long while. I sat and pondered the subjectivities in the science textbook that she taught, the standards dictated to her to teach, and her own standpoint as a white, middle class,

female educator. She didn't see the subjectivism in what she did in her science instruction. She viewed science as objective based on what she taught from the book and the county adopted standards. No doubt she had been taught that science is objective, and she continues the cycle by teaching her students the same information from the book.

As the room quieted once again, Addie shared with us how her cousin is battling ovarian cancer and the lack of care in the medical field in particular testing for women. Her cousin argued with many male doctors, fighting for her rights, and begging to undergo various tests until she was finally diagnosed at stage four. As Addie shared this story it prompted another story by Andrea who referred to her recent heart condition and how she was treated by her male doctors. She stated, "It pissed me off. It really made me angry! As a teacher and as a female they assumed it was just stress and put off my medical tests for two weeks."

The room hummed with conversation as each participant seemed to have a medical story to share. Deanna was the next to speak. She shared a medical story of how she had a cyst on her ovary burst while she was at school teaching. She left in the ambulance with her husband by her side. "Everyone acted all official that day. Then the doctor comes in the next day and acts as though I'm an idiot. My husband had been with me the day before, but now I'm thinking I've never seen this man before. He was my regular doctor." She was angry that the doctor showed more care and concern for her when her husband was with her, but when she was alone the doctor treated her "like an idiot."

These female teachers named specific examples relating to medical issues. Belenky et al., (1997) state that women's negative attitudes toward scientific abstractions

are usually founded in a concrete experience with a teacher, doctor, or male from the past. As the women openly shared narratives of medical issues where they experienced feelings of powerlessness, inferiority, and inability, the group began to name other ways in their lives where they felt these same emotions.

The conversation turned from medical care back to science as Ellie showed incredible insight into the hegemonic nature of science and society.

I remember when I was growing up in a large city. We had lots of science teachers and lots of choices. When my sister went through high school, she was not assaulted by the male science teacher, but there were some things there that made her very uncomfortable. When I was coming through, I took Honors Physics as a junior because I wanted to take AP Biology as a senior. My brother and I had the same chemistry teacher. We were six years apart. I, as a girl, failed and struggled, but he, as a male football player also did not do as well, but he passed every single time. We had to have tutor, upon tutor, upon tutor. All the girls in the class had to sit with the smarter guys in order to pass. I can remember that we cheated in that class off the smarter guys. That was the only way the girls could get through. What I mean by getting through, I mean only with a 70. We were borderline failing. Whereas, my brother's class they all did fine.

Deanna, once again playing the devil's advocate inquired, "Could it be the pressure of them all being football players?" Ellie thoughtfully replied, "Maybe, maybe, but again girls versus boys." Thinking about her science class she shared,

If you acted like a blonde airhead, 'Oh, I don't know how to do this!' Then they [the teachers] would come over and do it for you and you'd get an A on it. Where



everyone else would be left to explore it and do what you are suppose to do with it. It is interesting depending on the teacher. I hated science for that because I didn't learn anything. You had no idea how to prepare for the next class.”

Frustration and decline in self-esteem of girls beginning in middle school science are noted in research as being contributing factors to fewer women taking advanced science classes or pursuing science as a career (AAUW, 1998; Sonnert, 1995; Kahle & Damajanovic, 1997). Ellie's frustration with her science classes and male teachers was obvious to the group.

Sharing stories of injustice in science, school, medical field, and society in general wrapped the group in an invisible bond during our first hour and half together. Although these women came into the room with differing backgrounds and life experiences they soon noticed that many of their personal struggles were common to all the women. Time had passed quickly, so I prompted the group that I would soon start the video. A few left the room for a quick bathroom break while others refilled their plates with snacks.

I dimmed the lights and started the movie. It was interesting to note how some took each part of the video so seriously, sitting quietly and concentrating on the video, while others leisurely chatted and shared throughout. Either way I was inquisitive of their reactions. Fifty minutes later the video ended and the group was ready to share a discussion of their thoughts.

The video “Asking Different Questions: Women in Science” (1993) presented the value-laden nature of science and why the questions that female scientists and engineers ask are different from those asked by the majority of male scientists. After the teachers

viewed the video, the teachers were anxious to share. When I turned on the lights again, the room lit up not just with light, but with intense conversation. Everyone wanted to be the first to share.

The discussion started with the major theme of the nature of science as this was the content of the video. Katie immediately started the conversation using the video in support of her earlier argument of the subjectivities in science by noting that the female scientists in the video asked different questions than the male scientists to answer social problems. She noted that women scientists asked more “why” type questions.

Katie confirmed her earlier point,

It is very subjective in the way you question science from your background.

Women question science differently from the way that men question science. The methods that you may take to get to your data may be different. In the scientific method you may follow the same steps, but the direction that you question science is very subjective.

Ellie listened intently to Katie’s argument and added, “But also as a female it was talking about the emotional aspect of it.” Katie agreed that based on your background you may analyze data differently. She added, “Some of the women had background that had emotion tied to it, so when they got their data it determined what they did with it with their emotional background of the subject. It had a lot to do with their data once they were finished collecting it.”

Deanna returned to her same argument prior to the video and passionately added that the nature of science is the scientific method. “This is the first unit in my middle school textbook,” she retorted.

Erin shifted nervously on the sofa and finally decided to assume the argument. She said that she thought the nature of science was more of a “method of discovery.” The encounter stopped there as the conversation shifted to a common agreement between the two that science and its nature did not seem to be a priority in the United States compared to other countries.

Here the discussion turned to lack of female students’ confidence and achievement in the classroom. According to Erin, males are more confident with science than females. The majority of the group agreed and added that science was definitely “a boy thing” that even the girls would not dare to speak up in the science class or question the teacher. Numerous narratives emerged during this discussion. I will address these in a later section. More importantly, I want to note in this section that the group recognized that science is perceived as a masculine subject, although most did not understand its masculine, hegemonic roots. I derived at this conclusion by the various comments made that science was for boys, boys did well at science, and male students challenged female teachers in the science classroom. Additionally, the teachers did not share a common language on the nature of science. Most admitted not ever having thought about it and one other viewed it strictly as the scientific method as this was what the textbook taught.

The discussion took a turn from the nature of science to the nature of the female science teacher and what it meant to be a science teacher. Many tried to speak at once, but Erin hurriedly offered her opinion,

Nowadays not as much. Back when these women made their achievements that had to be the brightest of the bright. They had to be exceptional academically to reach the heights that they reached. I think that things are changing to the

betterment because of educators like ourselves. I don't feel like I am exceptionally smart or bright. I feel like I have achieved what anyone could achieve. But these women were obviously just smart."

Shaking her head in agreement Andrea says, "I really do feel exactly like Erin said that we have made gains and we have done this. You know, bottom line, I'm a girl and they know it and they treat me differently. My husband, my sons do, my students do."

Excitement mounted in the room when the subject of female oppression surfaced. Addie nodded enthusiastically in agreement, "Absolutely, Absolutely!" She seemed almost relieved to hear the comments of others. Likewise, Ellie chimed in, obviously excited that others shared her feelings, "Right, students do, students do."

Andrea, watched the support of others as she spoke, moved forward and motioned to the group and said, "I can give my all to science, make it this, make it that, make it cool and they still view me as a girl."

Erin exclaimed,

You brought up a good point! In my classroom, 6<sup>th</sup> grade advanced earth science, it is the male students who question me, and I don't want to say they attack me, but it does feel like they more than just question me. It's like they dominate the class, but they also are confrontational with me. The females never do. They are thinking, 'Oh my god, she is doing a great job and they are just ruining it for all of us.'

Thinking of how the male students challenged her, spurred her on to comment that science was a boy's subject and a career for men. Eagerly Ellie noted her observation

about the women in the video, “None of the women from the video had a ring on.” Others in the group nodded in agreement and several noted that the female scientists probably did not have any family. Erin agreed, “None of them had time. If they left their job, it would be taken, so there would be no family.”

“Their hair cuts are not cute and short. They are masculine haircuts, and they wore masculine looking clothes,” Addie candidly added. “In watching this video it is very sad to me,” Hannah openly shared, “All the women were masculine. They looked like lesbians, not to be ugly, but they did. They had to have the boy side of it to be able to do it (be a scientist).” Several others nodded in agreement that the female scientists had taken on a masculine look possibly to be more accepted. The teachers were concerned about the appearance of the women almost as much as their message. I sat back, listening and pondering, why they focused on the appearance of the female scientists.

While deep in thought, I was jogged from my contemplation to absorb the new direction of the conversation. Several teachers had noted that the female scientists in the video had gained the respect of their colleagues, not only for their outstanding brilliance, but also for their adherence to the masculine side of science. These teachers realized that these women in the video were unique in that they gave up their personal lives and feminine persona to pursue a career in a man’s domain, science. As Andrea commented on one woman in the video, “...that woman is so brilliant and so smart. Thank God, I wouldn’t want to be her. Really honestly, what’s that job to be so brilliant in a world full of men? Let’s be honest!”

It seemed to me that the teachers believed that these brilliant women made many sacrifices, including dressing masculine, giving up marriage, and children, against their

will. Of course, these “sacrifices” would only be considered a sacrifice if the female scientists did so in an attempt to be accepted in the scientific community. I don’t think that it occurred to the participants that these women may have desired their lifestyles. It appeared from the conversation that the teachers thought the women were sacrificing what they believed all women wanted based on societal standards (feminine persona, marriage, family) to be accepted in a masculine profession. The participants were looking at the female scientists and projecting their own meaning of what it meant to be a female. It should also be noted that the teachers may be displaying some homophobia in a belief that they do not want to differ from their socially defined roles and appear to be homosexual to be accepted into a man’s career. Andrea especially seemed irritated with the likelihood of a brilliant woman not being accepted based solely on her gender. Others expressed the aggravation that these women sacrificed so much to pursue a career of their interest and the only way they were accepted was based on their sheer brilliance and willingness to assume a male persona.

The discussion of stereotypical roles continued as the conversation moved to men in public education as being unnatural. “What’s the first thing you think of? He must be gay,” comments Andrea. Erin agreed, “Yeah, but you are thinking, teacher... uh, let’s find out a little more about him. And then it is all stereotyping right down the line. People will say what’s with him? Why doesn’t he get a real job?” With these comments my mind drifts to the history of the teaching profession as a well respected man’s profession until men left for professional careers and the profession became a traditional women’s career, losing status and respect with the gender change (Behringer, 1985; Grumet, 1988).

Many of the teachers became quiet and listened to the others describe stereotypical roles. Several teachers did speak up and say that they wanted men on their teaching teams. “Only a man can teach a boy how to be a guy and about respect.” I mentally noted the sexism in the statement, although she seemed unaware of it. Hannah agreed and then continued, “If a woman tries to teach a boy about respect it’s... Oh My God... they don’t care.”

Deanna was eager to comment on this new topic of stereotypical careers. Her beliefs and experiences were usually uncommon to the group, and she seemed to appreciate being the anomaly in the group. She shared with the group that her grandmother graduated from an all girls’ college in 1909 with a chemistry degree. Addie half-unbelieving remarked, “That’s uncommon!”

Deanna, jokingly asked, “What was my grandmother, though?” Waiting for no reply, she answered her rhetorical question, “She was a librarian! She was not in a lab, but all she did was read articles and that was it. She was a secretary/librarian for her group!” Other group members shook their head in disbelief of such a travesty. Finally, Ellie spoke up, “She was way too smart, but she was a female.” Andrea shuddered in disapproval, “Those were the times. You did what you were allowed to do.” Katie added, “To do what was allowed; to do what was expected of you.”

However Deanna, saw that the group had identified gender biases, smiled and exclaimed, “Trends now are changing. There are more women going into the university. There are more women going after the science jobs. And I’m wondering if a lot of it has to do with Title IX that hit much after probably around when you guys were going to school. Andrea inquisitively probed, “What’s the ethnicity of those people? I hate to be

that way, but let's bring it up. I have several Asian friends and people from India, all those chicks were engineering majors.”

Deanna explained that the ethnicity was across the board, and then explained that she chose science as a major because she wanted to be a pre-med student. As Deanna shared her experiences, I noticed that the conversation on career choices blended with college experiences. She shared that her father told her that she had to go to college. It was not really her choice.

Andrea once again noted the anomaly, “That is very rare!” Deanna continued to explain that her sister planned to be a nurse and she wanted to be one better than her sister. Ellie pointed out that Deanna probably had the confidence to pursue pre-med school because of her family support.

The conversation turned once again to families and career choices as Andrea shared her family's history.

My mother was the oldest of 13 and my dad was a baby of six. I was the very first person to go to college. I grew up in New Jersey where you were Catholic, Italian and that was it. It was all I knew. I didn't know that anyone else existed. Jewish, Catholic that was it. I was the very first person to go to college, but what did I become? A teacher, because that was a girl thing!! You were either a nurse or you were a teacher. Now I look back and say, “Gesh...Anytime, anything became out of my comfort zone, I went to the College of Engineering next door as a girl and said, ‘Oh I really don't understand this.’ I mean literally, I knew what I was doing, but I thought this guy is brilliant and I'm not. He's going to be able to do this in the College of Education that I can't do. You know what I mean? We had



to do things in education. It was the computer age, things that I couldn't do, but I knew if I went to the College of Engineering I could get some guy saying, 'Oh yeah, these chicks are standing there.' There was like eight of us. I used it. I was smart enough, but I didn't have the tools let's say. We did what we had to do. All of us were teachers. They were engineering grads and we were education grads.

Deanna listened intently to Andrea's story, and then confessed that she dropped out of pre-med because she was supporting herself and could no longer afford to go to medical school. Andrea interjected, "Well, there you go. It is very stereotypical!" Deanna shook her head seemingly in disgust, "Well, that's what happened I needed to get a job, so that's what happened." Andrea recognized the injustices in society by shaking her head as if she was not surprised, "You are a girl, you are a girl."

I listened to the conversation between the two and realized that Andrea and Deanna had summed it up in their stories what many group members appeared to have experienced. All the females seemed confident only in education classes. Even though Deanna said that she dropped out because of money, I question if some of the issues could have been lack of confidence or acceptance. Most of the teachers either believed and/or acted as if they believed the male students were smarter, especially the engineer and science male students. These women felt pressured to stay within their socially defined roles. Stepping outside the boundaries brought doubt and insecurity.

As I reviewed their conversations in my head, Andrea's comment prompted Erin to recall how her mom went to a prominent girls' Catholic college and graduated with a degree in political science, but she became a teacher. Ellie, the youngest of the group had been sitting quietly, finally commented, "A teacher! Of course, girls were teachers." Erin

continued to share that everyone told her mom that she wouldn't get a job in political science so she better be a teacher.

Ellie then began to share,

I went to college originally going to be a physical therapist, but because of my high school experience I backed off of that and because of my college experiences in science, I backed off of that and went into education. It was too... (her voice trails off)...it was the guys were overruling. It was too hard for me and I was feeling like a little lost soul, and I was out of my comfort zone. So when I got into education it was all good. I was the first female to graduate from college. That was huge. I don't know where it came from.

Hannah agreed, "I know my parents said do not be a teacher. They said, 'Oh my god, don't do it, but I did and they thought I don't know... they didn't have a choice, but like I had a choice. I never thought of going into that (teaching).'" Deanna shared that she grew up with all her teachers, not just science teachers, having the attitude that those that can't do...teach." Erin agreed that she had high school teachers who influenced her to not be like them. Hannah sighed and said, "Yeah... She's just a teacher."

The room fell silent as each one began to drift back in their minds to college days. Deanna broke the silence when she shared a story about when she and her husband go to dinner with other couples. He warns her not to tell them that she is a teacher. "Say anything! Say you are a garbage collector, a painter, anything." Deanna believed that he makes this request because everybody thinks they can be a teacher, and the conversation is soon dominated by what others believe teachers should be doing.

I listened to her share about their dinner dates. And then at one point, Ellie interrupted, looked at me, and inquired, “Would you want your daughter to be a teacher?” I realized then that teaching seemed to be a second choice for most. The focus group’s background as a whole was very much like my own background in that they first took other avenues, but returned to the acceptable female job, teaching. Most everyone had been told not to pursue teaching as a career either from a parent or a teacher.

I wondered why the teachers were concerned with choosing a career that was socially acceptable, even though they knew the job held a position of little respect in society. As I listened to their narratives and opinions, I realized that research states that social-cultural expectations classify women’s work (Bizzari, 1998; Taylor et al., 1995). The participants and I had been channeled into jobs considered women’s work by the expectations of society. I shook my head realizing how much we all had in common.

A silence fell over the room as we all contemplated our own journeys. With most of the teachers being mothers their thoughts drifted to their own children. Katie was the first to speak up and share her daughter’s experiences with a male high school science teacher. “He doesn’t really teach, but only does fun things,” remarked Katie. Andrea noted that her 6<sup>th</sup> grade daughter has a male science teacher who is all business. “He is way smarter than me. He thinks he is Mr. Star Wars and that’s what he is,” she exclaimed. The comment surprised me that she named a male peer teacher as “way smarter” than herself even though they both are science teachers in the same school. My thoughts drifted to her previous one regarding the male engineer students whom she trusted to help her with her education classes. Andrea has three extremely bright children, two boys and a girl. She names them as brilliant, yet states that her younger son is “way

smarter” than any of them. My thoughts momentarily wandered as I inwardly question if she has bought into the role of the weaker sex and feels powerless in society as discussed by Bizzari, (1998). I know women tend to underestimate their own abilities due to gender biases of educators and the inferior role assigned to them in society (Maher & Ward, 2002; Matyas, 1985). I looked about the room and asked myself, “How many of these women have been defined by others based on their gendered identity?”

Andrea’s voice brought me back into the moment as she continued to share that her daughter’s brilliant science teacher is not reaching her as a female student in the class even though she is gifted and ranks in the upper 5% of the students. I tell her as a mom, “Sweetie, don’t worry about it.” Andrea says that she would gender divide her own class and wish she could her daughter’s class if it were an option. “It is night and day. I have three children, two boys and one girl, I would gender divide them in a heartbeat, because I have a 6<sup>th</sup> grade girl who is gifted and she would no more raise her hand in a class of guys in a science room because she knows it’s not cool anymore.” Andrea’s voice and body language showed fervency and passion as she spoke about her daughter.

To the rest of us she said,

You know I’m not stupid! You know in the real world, what is she going to do?

You know the challenges put upon a woman are tough enough in the world, but to be put on a smart woman are even tougher. And I have to decide do I want my child to go through that. I have a 9 year old son right behind her. He is way smarter than all of us. And he is going to go through that [science] blowing up something one day. And I have to decide as a parent and a teacher, do I want my daughter who is really, really, bright to face those challenges?

I found it interesting that Andrea commented about the challenges of bright women. She made that point immediately after the video and once again pointed it out that her daughter is bright, but is not being reached by her male teacher. She appeared frustrated with the fact that her daughter is a bright child growing up in a man's world. As I listened to her share her thoughts with such fervor, I wondered what experiences she may have had that cause her to worry about her intelligent daughter in a man's world. I also wondered if any experiences caused her to buy into her own helplessness as she has shared throughout the night. She is a very intelligent woman, but often made belittling remarks of herself and always commented that the males in her life were smarter. Silently, I sat, listening, and wondering, "Why?"

Deanna, possibly noting Andrea's cry for help, responded, "Why not? Why not? Why not let her make those decisions?" Andrea obviously frustrated, "Because that would suck!! That would suck!! She would be the girl who never went out on a Friday night because she was so smart."

Deanna became more determined, "So what!! But maybe she may feel empowered. You have to understand all those women in that video none of them felt bad about being a woman."

Andrea passionately responded,

She dances and she does everything that you are supposed to do as a girl, but it is very hard though. It is much more challenging as a girl than a guy. I've already seen her friends go putttttttttt to her. My daughter wants to be a doctor. She wants to go to Emory. It is very challenging. She is really smart and science-orientated, but then she has all these guys that she worries about what they think

and how they treat her. I'm very women's lib, but my daughter is facing all these challenges already, because she wants to be a doctor. I'm not sure of what to do.

She is only in 6<sup>th</sup> grade.

As she shared, I recalled reading that children assume their gendered identities in schools and are shaped by a variety of stereotypical roles (Letts, 2001). I thought to myself this is surely part of Andrea's frustration.

Everyone listened and empathized with Andrea's plight. I looked around the room and noticed others related and understood, but offered no advice on what to do to fight the obvious male dominance in the science classroom and society in general. A few of the participants encouraged Andrea to tell her daughter to continue taking the higher level science classes, not to worry about the boys not dating her and about her girl friends thinking that she is "weird" for liking science. Showing obvious frustration, Andrea reiterated to the group that she has done these things, but continues to fear that her intellectual daughter will have a constant battle trying to make it in a man's science/medical field. As I gazed upon the faces of all the participants, I saw a shared sense of frustration, disappointment, yet a glimmer of hope of an undying determination to see other generations of young women push beyond the boundaries which have inhibited them. The collective thought of hope shone in the eyes of each woman not only for Andrea's daughter, but for all women who will persistently struggle to cross into the "man's domain" changing the face of science with a woman's voice, thoughts, and emotions. We can all hope.

As the evening came to an end, I turned off the recorder and asked each participant to complete the questionnaire again. Many lingered behind laughing and

sharing other stories. I found it interesting that the group bonded so well and so quickly. After the meeting, one of the participants pointed out to me that Deanna seemed “quite masculine” and “very outspoken and aggressive.” I found Deanna to be opinionated and firm in her convictions and eager to discuss any topic of the evening. She brought challenging and stimulating ideas to the group often playing the role of the devil’s advocate. I made a mental note that the subject of masculinity in women seemed to be an undertone of the night. However, the commonality of experiences and frustration connected the women even Deanna, the anomaly. I thanked each woman for participating and reminded all of them that I would be available to discuss any further thoughts with them next week. We said our good-byes and I knew these women would continue in the battles against injustices in their lives and their children’s lives. I smiled to myself and thought how pleased I was that our paths crossed for this one special evening of sharing.

#### Pre and Post Video Opinions: Changing Attitudes

The results of Appendix D provided a baseline serving as a pre-test to the study. The questionnaire was completed prior to watching the video or participating in the discussion. The survey results are shown here and in the table below. Three participants strongly agreed that science was objective, and five agreed that it was objective. Seven participants disagreed that science is free from social constraints and one agreed that she was confident that science was free from social constraints. Six disagreed and two were neutral that science did not have any subjectivity in it. Six felt science is not biased, one was neutral, and one strongly agreed. Four disagreed that they did not have equal treatment in the science classroom to male students, one was neutral, two agreed, and one strongly agreed that her experience was equal in the science classroom. Six did not enjoy

all science classes in middle school through college while two did enjoy them. Five participants stated that their teachers did not treat male and female students equally, while two agreed and one strongly agreed that they received equal treatment. Four recalled not having mostly positive experiences in science while three agreed and one strongly agreed that most experiences were positive in science education. Six participants stated that they enjoy science and enjoy teaching science while two were neutral on this question.

Table 1 Pretest Results

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I think science is objective.	3	5			
2. I am confident that science is free from social constraints.		1		7	
3. I know science does not have any subjectivity in it.			2	6	
4. Science is not biased.	1		1	6	
5. My experiences in science class were equal to the experiences of male students.	1	2	1	4	
6. I enjoyed all of my science classes in middle school through college.		2		4	2



7. My science teachers treated male and female students equally.	1	2		5	
8. I recall mostly positive experiences in my science education.	1	3		4	
9. I enjoy science.	3	3	2		
10. I enjoy teaching science.	4	2	2		

From analyzing the survey results, it appears that most teachers enjoy science and enjoy teaching science even though they did not recall positive experiences in their science classes from middle school to college. Most participants believe that they did not receive equal treatment to the male students in the classroom. Additionally, most participants believed science to be objective, but may contain some subjectivity and biases in it. Seven of the eight teachers recognized that science is not free from social constraints. During our discussion prior to the video some teachers even shared narratives of how their brothers or other male students were favored in the science classrooms. These results are indicative of the research conducted in the literature review which states that science is a social constraint which is not neutral and contains biases (Gilbert & Calvert, 2003; Harding, 1991; Mayberry & Rees, 1997).

Additionally, most teachers in the focus group recognized that science has biases, subjectivities, and is represented differently to males and females in the classroom. These

opinions on the questionnaire and in the narratives, discussed later in this section, symbolize that many female educators are aware of biases in science education. Tindall & Hamil (2004) discussed the gender gap between boys and girls in science achievement, and Maher & Ward (2002) discussed stigmas and labeling in the science classroom. In agreement, Sadker and Sadker (1994) found that teachers interact more and in more detail with boys. Gender inequity research unveils inequitable pedagogical practices that favor males.

Appendix D also served as a post-test to the viewing of the video and our discussion as a C-R focus group. The results of the questionnaire are shown below. The numbers highlighted in yellow are the results from the pretest. The other numbers are from the posttest. This enables one to compare the changes in attitude from the pre-test to the post-test at a glance.

Table 2 Comparison of Opinions Prior to and After C-R Experience

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I think science is objective.	3	5 1		5	2
2. I am confident that science is free from social constraints.		1		7 6	2
3. I know science does not have any subjectivity in it.			2 1	6 7	
4. Science is not biased.	1	1	1	6 5	2

5. My experiences in science class were equal to the experiences of male students.	1	2	1	4	1
		2		5	
6. I enjoyed all of my science classes in middle school through college.		2		4	2
		2		5	1
7. My science teachers treated male and female students equally.	1	2		5	1
		1		6	
8. I recall mostly positive experiences in my science education.	1	3		4	1
		3		4	
9. I enjoy science.	3	3	2	1	
	3	2	2		
10. I enjoy teaching science.	4	2	2	1	
	4	1	2		

From the results we can see that most teachers changed their opinions on the nature of science. Before the C-R experience, eight teachers agreed or strongly agreed with the statement that science is objective. After participating in the C-R group, seven teachers disagreed or strongly disagreed with the statement that science is objective. This was the most dramatic change on the questionnaire. A few teachers recalled negative experiences in regards to science classes and changed their opinions on the survey.

However, prior to the focus group many teachers seemed to understand already that science is a social construct. Therefore, not many opinions changed in these categories.

## CHAPTER 5

### CONSCIOUSNESS RAISING: BRICK WALL REMOVAL

The concluding chapter of this dissertation is separated into four parts. The first part discusses the culture of science versus the nature of science and how these terms were used in the study. The second part discusses significant findings of the study. The results are presented in themes and are interpreted in light of the research questions and discussed in conjunction with literature. I weigh the results of the dissertation against the aims and the objectives. Themes center on lack of reflection and need for critical analysis, silencing, and inequitable opportunities. This section ends with suggestions for future research which include further research needed in the area of critical analysis of teachers' experiences. The second main part of this chapter discusses the strengths and limitations of the study. One strength of my study is starting my research from the lives of marginalized females. A limitation of my study is the similarity of the participants' experiences to my own. Finally, I close with a summary and conclusion section recapping the use of Critical Race Feminism and Feminist Standpoint Theory.

#### Culture of Science versus Nature of Science

At this point it seems imperative to discuss the terms "nature of science" and "culture of science." The participants in my study seemed somewhat confused with the terminology "nature of science", so I further explored other possibilities for future studies and the connotations carried by the term used in my study, "nature of science".

Science of all forms is located in a cultural context and from a social location (Harding, 1991). Scientists chose what to work on based on their personal interest. They approach their topics with preconceived ideas and analyze data based on their own

thoughts. Social roles and viewpoints come into play as scientists complete scientific investigations. This social side of science is considered the “culture of science” (Scalon, Murphy, Thomas & Whitelegg, 2004). Cultural knowledge is often assumed to be inferior to traditional science learning and thought; therefore “Western science taught at school, is often shown to be superior to knowledge within the local culture” (Scalon, Murphy, Thomas & Whitelegg, 2004, p. 155). Traditional science instruction disrupts a student’s worldview and “forces that pupil to abandon or marginalize his or her life-world concepts” (p.155). Thus, the social side of science is in conflict with what students learn to be the nature of science, the natural order of science in the world of science instruction.

The term nature of science carries the preconceived notion that science derives from a usual, natural, objective system. Therefore, the term itself may uphold the hegemony present in science today. Textbooks present the scientific method as the nature of science; thus presenting, without argument, that the objectivity of science is the nature of science. Students and teachers do not think to question what is presented to them as perfectly natural. They are not given the opportunity to question or suppose that science could be anything other than the natural order of what is truth. “Truth is supposed to emerge unambiguously from experiment” (Scalon, Murphy, Thomas & Whitelegg, 2004, p.4).

Therefore, in my study my participants may have responded to the term, “nature of science” as a programmed response. They believed science to be objective, yet also stated that it was influenced by social aspects. I contend that teachers would benefit from further exposure to the term “culture of science” which is the consideration of science’s

cultural, social aspect. “Scientific knowledge is viewed as tentative and imbued with the values of the individual and the culture in which it was generated,” (Barton, 2001, p. 16). Therefore the term culture of science should be further explored and used in studies and discussions to make others more aware of the cultural aspects of scientific knowledge.

### Significant Findings

Employing a theoretical framework of Feminist Standpoint Theory and Critical Race Feminism, the central intent of my feminist study was to expose the masculine hegemonic nature of science to a group of female science teachers. In my study I attempt to break through the mental barriers that exist like brick walls built from years of science training, hegemonic experiences, and lack of reflection and analysis on the part of the teachers. Thus, my study focuses on how female science teachers perceive science and how they reacted, reflected, and responded to the message in the video.

Feminist Standpoint Theory reminds us that all views are partial and biased with socially situated knowledge. By acknowledging social location, which is reflexivity, and adding subjectivity to the research my study becomes more objective. Critical Race Theory reminds us that the views of my middle class, white women participants are not a monolithic voice for all women. Their views are only a white, middle class female perspective with opinions based on the intersection of their race and gender. It is critical to note this as Feminist Standpoint Theory alone does not address issues of race and gender. With these tenets in mind I began to examine the events of the evening with my group of teachers. The over-arching themes are lack of reflection and need for critical reflection and analysis, silencing, (due to intimidation, learned helplessness, and oppression), and inequitable opportunities in the classroom and in career choices. I will

discuss each theme individually employing my theoretical framework with the research questions in mind. Additionally, I will use examples from the data and integrate previous studies and what my study has done differently.

#### Reflection and Analysis of Science

The need for reflection and critical analysis has been cited in research often, especially in the field of education (Argyris & Schon, 1980; Barid, 1999; Halai, 2004; Hammrich, Richardson, & Livingston, 2000; Keller, 1985; Smith, 2005). My study supports these in that the teachers in the focus group showed a need for reflection and analysis of not only their lived experiences, but particularly their learning experiences and subject matter that they teach. My study differentiates from others as it asks teachers to reflect not only on experiences, but to reflect on and analyze science, the subject they teach, and to reflect on their experiences relating to science.

#### *Objectivity of Science*

First of all, it should be noted that prior to the video a shared, common language on the nature of science did not exist among the teachers, and many participants commented that they had not given the nature of science much thought. This lack of a common feminist language tells me that science is not a subject in which females have acquired a feminine language or common discourse. The teachers seemed baffled or frustrated with this topic as they are accustomed to teaching state-mandated standards from the science book, which refer to the scientific method as the nature of science. This narrow view of the nature of science hinders teachers and their students from discovering the historical roots of science and demands that they follow the strict protocol of proper science.



Additionally, it is significant to note that the teachers had not reflected on their subject matter to be able to adequately respond to my inquiries on the nature of science. Hannah spoke up and shared that she had never really thought about the nature of science, but considers herself an objective science teacher because she relies totally on the book. This means to Hannah and other teachers like her that she just delivers the message that she receives from others without thinking about her subject matter. This supports the findings of Lederman (1995), who states that teachers rarely think about the nature of science when making instructional choices. From the questionnaire prior to the video, the teachers believed science to be objective, yet viewed it as influenced by social constraints. They seemed unaware that science cannot be a biased, social construct and still be objective. This supports the findings of Bleier (1991), which state neutrality and objectivity are presumed to be a defining feature of science.

I found it interesting that the teachers did not understand their own contradictions in this area. These mixed results could be an expression of the cognitive dissonance teachers were experiencing due to the difference in what they have been taught about science and what they have experienced as science teachers and learners. My study supports the findings that teachers view science as a body of objective knowledge (Scalon, Murphy, Thomas & Whitelegg, 2004). Yet, it differs from others as it inquires into how teachers will respond to the message that science is not objective, and if they will connect it to their own lived experiences.

That fact that the participants were unaware of the fallacy that science is objective reveals that they had not deliberated or critically analyzed the nature of science or their lived experiences. Their experiences did not align with what they had been taught about

science. Several participants named gender-biased science teachers, teaching experiences, and medical experiences that revealed the prejudiced subjectivities of science. Yet, they clung to the objectivity of science basing their beliefs on the textbook and their training. This is significant to these teachers as they are not thinking for themselves, but parroting what others tell them is the truth.

Hannah commented that science was objective because that's what the book says. Deanna agreed that the book teaches the nature of science is the scientific method and that method is objective. Yet, Katie was the only participant that recognized the subjective, social nature of science. Deanna insisted she understood science as a form of training and with more training we would all understand that science was objective. She believes "if you have taken a lot of science classes and courses and been in the scientific community as a scientist you understand that it is objective." Katie tried to convince Deanna and Hannah that science was not objective because it depends on who is analyzing the data. Katie states, "In the scientific method you may follow the same steps, but the direction that you question science is very subjective." Prior to the video, the others did not agree with Katie as they had not seriously analyzed science or their experiences for themselves. As mentioned earlier, Katie, a special education science teacher understood how many individuals are treated unfairly based on differences. This means that Katie had critically analyzed science as a social subject and understood many students are marginalized by traditional science. She knew science to be a subjective, social construct because she had resisted the training and textbooks and thought for herself. She reasoned beyond the boundaries set by her teachers and the science text. Hannah, unlike Katie, but like most teachers and students, unquestionably

accepted the presumed authority of the teacher and the text and did not question the objectivity of science even though she knew it to be a social construct. This means that Hannah and many other women fail to challenge what is presented to them as natural law or the natural order as science is often portrayed. Deanna supported the hegemony of science the same, but to a higher degree. She has totally given up critically challenging what she has learned to be Truth about science. This means to her and women like her that they have moved past losing their own power of choice to a place where they don't even recognize their own predicament. Her excessive training in science has caught her in the mire, and she is unaware of her plight. She is convinced she is right and everyone else in the group is wrong. This is a dangerous thought process for anyone.

Research reveals the risks of excessive training in a specific subject as leading to overspecialization. "One of the main dangers threatening science teaching comes from overspecialization" (Gros, 1996, p. 327). Overspecialization can have a detrimental consequence of losing perspective and self-confidence (Armstrong, 1994). It appears that Deanna has been influenced by overspecialization as she states that with more training everyone would understand science is objective just like she understands it to be. She stated that science was not about discovering your own. This statement reveals that she has conformed to the scientific mold wholly believing all of science's claims of objectivity giving up her own thoughts. Katie could see that Deanna had accepted her science training as Truth and was not willing to analyze the objectivity of science for herself. This supports Armstrong's (1994) findings that overspecialization can lead to loss of perspective.

Although most all the participants had experienced science as a gender-biased boys' subject, even Deanna, they all blindly accepted the objectivity of science, except Katie. I believe this double minded way of thinking is a result of allowing their science training and subtle manipulations in science classrooms and textbooks to control their personal beliefs regarding science. Deanna has lost self-discovery and personal perspectives on science as she has totally conformed to the scientific community in which she was educated.

Female teachers unknowingly replicate the fallacy that science is free from social constraints and subjectivities. Blindly following science's presumed objectivity through biased books and classrooms, females are denied possibilities of intuition, muse, and real deliberation because they have not reflected and analyzed their lived experiences in and out of the science classroom.

Prior to the video the teachers just assumed that science was objective because that is what they have learned and what they teach their students. A premise of Feminist Standpoint Theory is that scientific knowledge provides a view from nowhere. That it speaks with the "god-trick" of not being situated in any one place. This theory "questions the god trick" of science (Whelan, 2001; Haraway, 1988). After the video and discussion, the group understood that it is impossible for any scientist to speak from nowhere, that all scientific knowledge is socially influenced and cannot be objective. The women changed their views on the objectivity of science, all but Deanna. She continued to tell the group with more training they would understand that science is totally objective. All other participants decided that science's social nature kept it from being truly objective.

The data moved significantly in the questioned objectivity of science. This movement could possibly be a result of groupthink, a way of thinking in a unified group where the members are searching for unity and members agree easily (Rook, 2006). The participants may have accepted the message in the video because they felt the power of the group convincing them to go along with the majority. However, symptoms of groupthink usually occur when group membership is highly valued and the members are experiencing tense situations, fearful of exclusion from a cohesive group, and share in high risk decisions (Garnett, 1997). None of these were attributes of our Consciousness-Raising group experience. In actuality, our group never produced an entire cohesion of beliefs as one member, Deanna, persistently held to her base belief of science's objectivity.

Equally important to note is the movement in the data could be a result of the white women's perspective that they are oppressed. Recognizing they have been subjugated in society in other ways due to their gender, may have released the women to accept the new information that science carries subjective, masculine roots. Thus, they were willing to identify with the message in the video. Feminist Standpoint Theory starts with the lives of the subjugated groups to combat sexism and reminds us that in a power relationship that the oppressed are more open to accepting new ideas. Thus, these women may have had a critical awareness and recognized a need to change their science beliefs. Feminist Standpoint Theory reminds us that once these women become conscious of the prevailing and subtle influences in their lives they will start to achieve unrealized potential.

### *Masculine Science*

The video "Asking Different Questions: Women in Science" (1993) became the tool for breaking down the brick walls that constrained these women from analyzing science and their lived experiences. My study supports the feminist's critiques of Franz and Stewart (1994) and Tindall and Hamil (2004) as they investigated how the nature of science influences what questions are asked, who asked the questions, and how the data is interpreted. Prior to the video, Katie understood that science is subjective because "it depends on who is asking the questions" and how he/she interpret the data. Katie realized as a female she would ask different questions from men. After the video she noted, "It is very subjective in the way you question science from your background. Women question science differently from the way that men question science."

Science originated in a historically patriarchal period, where the feminine voice was barred, and the nature of science presumed objectivity (Bleier, 1991; Keller, 1985). With these roots, it is no surprise that even today female teachers lack a common language or understanding of science. It is significant to note that masculine scientific thought continues to course from teachers to students with no understanding of science's masculine roots. Matyas (1985) found that science teachers should avoid conveying perceptions that science is for males. Teachers should emasculate science in their classrooms and this can only occur after they have become aware of science's masculine nature. My study exposes teachers to the subjective, masculinity of science and urges teachers to examine their lived experiences and teaching for biased subjectivities.

My findings show that teachers will accept a message dethroning traditional science. After being exposed to the biased, presumably masculine nature of science, the

teachers seemed to critically examine their beliefs and experiences. A significant finding in this study is that science teachers are willing to accept other views of science, if they base their beliefs on other viewpoints besides training and the textbooks. The teachers eagerly embarked on a learning endeavor to discuss this newfound knowledge of science's roots. They promptly moved from their years of high school and college textbook training to a more personal form of inquiry, their experiences in and out of the classroom. This means for these teachers and female teachers in general that they are able to push past the boundaries that limit them if they receive information that can be assimilated into prior experiences.

These females identified with the masculine roots of science and begin to understand that their struggles with science were not just a personal problem, but a wider more political problem which others had encountered. This is important because the teachers shared a moment of conscientização when they realized for themselves how limitations had been set on them by others (Freire, 2001). This moment of critical awareness, much like light shedding in a dark corner, reflected on the faces of the teachers throughout the room as they begin to talk over one another eager to share their thoughts. The knowledge of the roots of science seemed to explain to them why they experienced a weakened relationship with science. It should be noted that this could be a manifestation of groupthink, but only additional research could answer that quandary. A follow-up study which would reunite this group after a few months possibly may further explain the impact of groupthink in my data collection.

## Silencing Experiences

The theme of silence is a persistent theme in research on girls and women (Belenky, Clinchy, Goldberger, & Tarule, 1997; Gilligan, & Sullivan, 1995; Iglesias & Cormier, 2002, Taylor et al., 1997). Silencing is the eradication of an individual's or group's voice based on race, class, sex, and/or gender. This hegemonic strategy used to suppress or remove the voices of others includes experiences of intimidation, learned helplessness, and oppression. Silencing of women in science is often claimed by others to be justified as women are socially defined as more emotional than men, therefore more subjective, biased, and irrational (Jaggar, 1996). This argument stereotypes women and further subjugates them by categorizing and marginalizing females in science inhibiting their voices and opportunities to achieve in scientific fields.

Gilligan (1982) asserts that women lack a language to describe and interpret their experiences. Women need progress through Gilligan's five ways of knowing from silencing to knowledge construction where they can create meaning from their experiences. The discussions in the group and the opinion data on the questionnaire showed changes after the women viewed the video and shared experiences. The narratives were engaging and encouraged others to share. This supports the findings of Gilbert and Calvert (2003) who assert that stories based on experiences become the framework in constructing identities and relationships and provide a way to engage young women in science.

Learned helplessness, hopelessness, and emotional disengaging are all attributes of girls in science, schools, and society (Franz & Stewart, 2001; Ryckman & Peckman, 2001). My study supports the findings of these studies as the participants in my focus



group shared stories that named attributes of learned helplessness, hopelessness, intimidation, and emotional disengaging. It differentiates from other studies in that my participants were not asked to just recall experiences. They were first asked to view the video with the message of subjectivities in science and then share experiences that were evoked as a result of the message.

Ellie shared with the group that acting “like a blonde airhead” would get you through science class. She showed signs of learned helplessness meaning that she had perceived herself as unable to do the work. She had learned to believe that she was helpless in science class and believed that she had no control over the outcome short of having the assistance of the teacher or a male student. Andrea displayed learned helplessness when she shared her story of taking her education assignments in college to the male students in the engineering department for help. She said, “I was smart enough, but I didn’t have the tools.” Andrea and Ellie both had succumbed to the power of learned helplessness.

This links Andrea and Ellie specifically because they displayed signs of learned helplessness, in that they were aware of their potential, but did not tackle the academic challenges for themselves. This is important to them and many other women because learned helplessness impedes them from the opportunities to experience success and failure from their own endeavors. They only experience the failure of never trying to complete what possibly could be achieved on their own efforts. These women lack the joy of struggling through on their own, facing challenges, and finally breaking through to reach their goals. These types of experiences are the ones which build self-confidence and perseverance to press the boundaries which often constrain and limit one’s choices.

Learned helplessness silences females in science classrooms and allows the voices of the culture of power, white males, to continue to dominate learning. Looking deeper into this issue, we find the culture of power, white males, continue to have the authority in science classrooms blocking out female students like a brick wall. Even my group of 4<sup>th</sup> grade girls told me that they were not “supposed to” join the science team or speak up in science class that boys would make fun of them if they did. Delpit (1995) states that the culture of power sets the rules in society. The experiences of the teachers in the C-R group reveal that the culture of power, white males, dictated the rules in science classrooms. My study opens doors to explore how this culture of power can be unseated in the science classroom and obtain a more feminine nature of science. My participants were exposed to science’s more subjective, social side, thus gaining knowledge and insight through the video, and then were able to recall silencing experiences in their lives. Several other teachers shared silencing experiences, such as feeling inhibited to speak up in their high school and college science classes. Erin commented that as a teacher she was challenged in her own science class by the male students. This resulted in feelings of intimidation and pressure. These experiences created an atmosphere of hopelessness and fear. The teachers, not only as female students in science, but also as female science teachers named experiences which inhibited their voices and raised feelings of fear and powerlessness.

This is important to these women and others, because they have yielded to intimidation and fear and failed to daringly challenge those who threaten them in obvious and subtle ways. This behavior of freely yielding continues in other areas of their lives as they surrender to societal roles and demands. Like many women who give into fear and

intimidation, they never confront those who frighten, scare, or bully them into submission. They have given up their power of choice and are left with no voice. From the in depth conversations of the group, it appears this same silencing and lack of language issues continue throughout science classrooms today. The nature of science and science practices continue to have the same silencing effect on women as it did in the eighteenth century when its roots were first established and women were purposefully excluded (Bleier, 1991; Keller, 1985). Female teachers and students naively stand silently aside as they let male students and teachers control science learning. Once the teachers began to find a voice, individually and as a group, it became apparent that their experiences had common traits of learned helplessness, hopelessness and intimidation

Prior to the video a common language had not existed. After viewing the video, collectively they began to name unfair experiences and construct thoughts and ideas that had not surfaced prior to the video. Although I reiterated that I did not seek a group consensus, the group reached an informal consensus that the video's meaning shed light on their unexplored experiences and beliefs providing a way to remove the bricks and begin the quest for critical awareness. This is important to these teachers, because in general most all the teachers begin to realize how their early experiences still controlled their thoughts today. Once the teachers recalled early lived experiences of fear, intimidation, and learned helplessness, they begin to recall how these fears and vulnerabilities still existed in their personal lives and classrooms.

Halai (2004) found that early life experiences direct teachers in their beliefs and practices in the classroom. Halai (2004) and Lederman (1995) agree that it is vital for teachers to make this connection so they can apply it to classroom practices. My study

deviates from others here as teachers were first exposed to new information and then asked to develop an understanding and personal connection of this newfound knowledge to their prior experiences. The teachers reflected on the nature of science through the lens of their personal experiences. My study shows how attitudes have been formed from experiences and the need for teachers to reflect on and tap into the meaning of these experiences.

Biklen (1985), Kahle (1985) and Smith (2005) all assert that additional research should be completed which examines the lived experiences of science teachers as few studies have been done in this area. My study attempts to close the gap by adding to the knowledge base of science teachers' lived experiences. It deviates from the main stream studies on the underachievement of women to address more of how women feel and what they think about the nature of science, and their experiences in science. Halai (2004) concluded that when teachers are able to identify experiences they gain insight into their beliefs and practices.

### Loss of Opportunities

Loss of opportunities occurs daily in society for females due to many different factors. For this study, I would like to discuss stereotyping as a tool used against women leading to lost opportunities in the classroom and in career choices. Stereotyping is a way in which individuals or groups are categorized based on a generalized image or scheme. Stereotyping results in preconceived notions that create unfair and unequal treatment of individuals. From the C-R group the loss of opportunities surfaced as a theme as women discussed ways in which they had been categorized and labeled based on their gender. Stereotype threat is a term used in Critical Race Theory to describe when a marginalized

individual is aware that others have labeled and categorized her based on her socially defined gender and/or racial roles in society (Cleveland, 2004). These women believed that they had no other choice, but to fit into the mold of culturally defined gender roles. Stereotype threat is a hegemonic strategy which creates unfair, biased, inequitable experiences by labeling individuals based on race, class, or gender. The participants particularly recalled these types of experiences based on their gender.

In this section, I will first discuss stereotyping in the classroom as a way in which the participants experienced a loss of equitable opportunities. Next, I will discuss stereotyping of careers as the women shared many narratives regarding their lack of opportunities in career choices. Finally, I will end this section with a discussion of socially defined gender roles.

### *Stereotyping in the Classroom*

Goldman-Segall (1996) uses the term gender-flexing, as a way for students to step outside their stereotypical roles in schools and particularly in science. Boundary crossing and elimination of stereotypical beliefs is essential for females to experience equitable opportunities in the classroom. Gilbert and Calvert (2003) find science to be unattractive to women. While Sonnert and Holton (1995) and Sadker & Sadker (1994) find that science is considered a masculine subject by children. My study supports the findings of these studies as my participants said that they recalled few positive science experiences and did not like their science classes. Additionally the stories of my teachers reflected a fear of stepping outside their “comfort zone” so they refused to take advanced science classes. Andrea worried that her daughter will become masculine or “nerdy”, or will sit at home on Friday nights without a date, if she continued to take science classes through

high school and college. These negative stereotypes of women in science inhibit many females from pursuing science careers. Stereotypes impede females from reaching their full potential (Maher & Ward, 2002).

Research shows that females are treated differently in the science classroom and male students are favored by science teachers (Sadker & Sadker, 1994; Tindall & Hamil, 2004). My participants stated that they were not treated equally to their male counterparts and boys received better grades in their high school classes. It would be interesting to research if they perpetuate this in their own classrooms and if male students actually get better grades. Additional research shows that teachers have a low expectation of female students which contribute to their demise in the science classroom (Mayberry & Rees, 1997) and hold a higher expectation for boys (Tindall & Hamil, 2004). Several of the female participants in the group stated that they felt inhibited in their science classes and avoided taking science classes with male teachers.

The teachers named experiences of being treated differently in science because of their gender. Erin said that one science teacher at her high school would just do the work for the girls. She said that she hated science for that reason because she didn't learn anything. This held her back from taking advanced science classes, because she didn't know what to expect having not done the work in her lower level classes. Additionally, this is important in Erin's life and the lives of other women because their defined societal roles inhibit them from venturing into other careers or grasping opportunities which may arise. I say that Erin and the group in general have succumbed to stereotyping, because they did not press beyond their defined roles in science class or society. They settled quietly into the pigeonhole defined for them and did not press beyond in questioning the

teacher, taking more advanced classes, or challenging the male students. People who surrender to stereotypes lose opportunities because they have limited choices.

The findings from my study support research that states traditional science learning has inhibited females due to the socially constructed nature of science, socio-political issues, and stereotypes (Harding, 1991; Sonnert, 1995; Debacker & Nelson, 2000). My study differs as it provides the teachers with a message explaining the presumed masculine nature of science. Teachers are exposed to the message and provided the tools to construct meaning to their lived experiences.

### *Stereotyping in Careers*

One main theme that reoccurred in the conversation regarding inequitable opportunities was that of career choices. The inferior and powerless social location of women often constrains and constricts their career choices funneling women into traditional female careers, teaching, nursing, and other service jobs (Bizzari, 1998). A significant finding in this study is that teachers in the focus group were able to name the common experience of how they felt subtle and not so subtle societal pressures pushed them into teaching. Although, some of the participants may have realized this during their careers, others may for the first time started to understand the societal dynamics which influenced what they thought was their choice to become a teacher. This is consistent with literature that states gender-role socialization often limits the achievement of women and leads them into nurturing careers (Sadker & Sadker, 1994; Sonnert, 1995). It is important to note that with each new awakening of hegemonic, societal forces, the participants became more empowered to discern and name others in their lives.

McCormick (2005) argues that stereotyping leads to a lack of respect for women and represents education as women's work. The findings from my study support the stereotyping of education as women's work in that the women felt socially impressed upon to become teachers despite their own wishes. Behringer (1995) states that, in the sciences, women had a minor role and lower status. Deanna shared even though her grandmother received a chemistry degree in 1903 she was still a librarian for the male scientists who worked in the lab. Stereotyping of careers creates social pressures that direct women into predetermined careers, and the socialized direction of feminine roles does not include science (Matyas, 1985). My study supports these findings as all the teachers felt that science was not a feminine career. Even Deanna, the one teacher who actively pursued a degree in science (pre-medicine), was eventually funneled into a teaching role.

Ellie originally had the goal of being a physical therapist. She shared with the group that her high school and college science experience caused her to "back off" of that dream, and she went into teaching. "Girls were teachers," she shared with disappointment in her voice. Erin and Hannah shared that their parents and teachers discouraged them from becoming teachers. Hannah said that her parents believed that they didn't have a choice, but she did. None of the women felt as if they had a choice.

I questioned why the participants became teachers when others influenced them not to do so. Deanna quit medical school for financial reasons and went into teaching. She said, "I needed to get a job." Ellie chose teaching over physical therapy because she had bad experiences in science and felt more secure in education. Ellie referring to her science classes shared, "The guys were overruling! I was a little lost soul out of my



comfort zone.” Andrea said that she chose teaching because “it was a girl thing!” The other teachers agreed. I even reviewed my reason for pursuing teaching. Despite having a BBA I could not find a job. I thought to myself, “Well, if I teach I’ll get a job and it will make it easier for my family once I have children. My schedule will fit my children’s schedule.” Also, I recall my older sister’s question to me when she started college, “I’m going into education, so I can get a job. What will you do with a business degree?” I concluded that others pursued teaching just as I did due to societal pressures. Assuming acceptable stereotypical roles for women and choosing a career that fit the traditional woman’s role in the family were the factors in career choices that linked these women and me.

Additionally, it should be noted that Deanna, Erin, Ellie, and Andrea are all linked together as they yielded to the subtle and covert manipulations from predetermined societal mores. This is important because they all let others control them. Like many other women, they never learned to take control of their own lives and subsequently lost opportunities to make personal choices and move beyond set boundaries determined by society. Additionally, this led to a loss of self-esteem. Not making decisions for themselves led to feelings of not being in control of their own lives. Giving up power of choice to others is giving up more than that particular opportunity. It means giving up a piece of yourself a little at a time. Many women give themselves up piece by piece day after day through manipulation, intimidation, learned helplessness and fear. This leads to inequitable opportunities. For this reason many women, choose teaching as their career.

Teaching is considered the acceptable job for women because it is historically grounded as women’s work. Parents and others may tell girls not to be teachers, but I

think economical reasons and detrimental experiences in other subject areas, such as math and science, deter girls from following personal career ambitions. Additionally, parents, teachers, the media, and others may inadvertently send messages that masculine careers carry a masculine stereotype. A key example of this is Andrea's fear that her daughter desires to become a doctor. Parents often consciously and unconsciously guide their daughters away from these stereotypically masculine careers and at the same time deter them from pursuing the traditional feminine career in education. Many girls may fear the ridicule of their peers and males if they chose a stereotypical masculine career. This is important to the women in this study and all women, because eventually the girls give in to societal pressures and mixed messages from their parents and pursue a traditional, socially acceptable feminine field, teaching. When they chose teaching because of stereotypes, they are not choosing other fields, such as math, science, and technology. These fields may hold interest to them and the fields would benefit from a feminine influence, yet the opportunities are removed when the teachers follow mores.

It is important to mention here that Critical Race Theory addresses issues of race and these societal pressures the women felt that directed them into teaching jobs are the perspectives of white women. When they speak of science and careers, it is in terms of their perception of a white man's profession. The issue of race was not discussed in the area of careers, because only white women participated in the study. No other race besides white was part of the potential subject pool of female middle grades science teachers. It should be noted that not only are few women in science, but even fewer black or Hispanic women are in science. Even the video "Asking Different Questions: Women in Science" (1993) did not show any African American or Hispanic female scientists. I

contend that the discussion would have taken on a different element if other races of women were part of the potential subject pool. These white women experienced many hegemonic, oppressive experiences where their choices were denied or controlled by societal oppression and stereotypes. I argue that if African American women would have been available for my study, they would have shared experiences of oppressive controlling power structures in the areas of gender, class, and race. These experiences, both subtle and overt, would have denied them real opportunities to obtain a career in a white man's field of science. I am sure African American women and other minority races of women would have extra barriers and obstacles to overcome in schools and the scientific community than that of white women.

Critical Race Theory has the core assumption that physical differences create differences in political power (Wing, 2003). Thus, it maintains the views of these women that they were barred from masculine science and directed into a feminine teaching role because of their physical differences. The physical differences of being white and female or black and female are enough to become an obstacle into the white man's world of science.

#### Culture and Gender

Cultural beliefs are embedded in self-definitions of women which lead to powerlessness, loss of voice, and sacrifice of personal goals. Freire (2001) asserts that women are molded by their "invaders" in society to assume inferior roles. Loss of voice (Belenky et al., 1997; Iglesias & Cormier, 2002; Sadker & Sadker, 1994; Taylor, Gilligan & Sullivan, 1995) and sacrifice of personal goals for others (Bizzari, 1998) are previous findings which my study supports. These overarching broad themes have been further

analyzed by looking deeper into the experiences of the participants to determine the causes.

Additionally, it was interesting to see the world-views of the women unveiled. Andrea displayed signs of fear that her daughter may become masculine or “nerdy” if she pursues a career in the sciences. She commented often about the challenges of bright women in science. She shared several times that her daughter wanted to become a doctor, and she had many concerns and fears for what her daughter would suffer to achieve this goal. Is she concerned that her daughter will become masculine if she pursues a medical career? It seems to me that she is displaying signs of homophobia as her concern lies with her daughter’s image and what others will think of her. Is she concerned if men will find her attractive and date her, or if she will cut her hair short, wear pants and date other women?

She explains that her daughter “does all the things she is supposed to do as a girl.” She believes that her daughter is on the right track socially, because she is doing “what she is supposed to do.” However, her fears are grounded in that she will not be able to continue doing what she “should do” as a girl and still realize her dream of being a doctor. I believe that Andrea has accepted the social positions of women and would like to see her daughter achieve her dream without stepping outside the socially-defined gender roles of a female. However, I believe that she realizes that her daughter will not be able to achieve her dreams and still remain within the socially defined gender roles for females. She recognizes that females can’t do both, thus her frustration. She doesn’t make it clear to the group members this is why she is frustrated. Maybe the contradiction is not totally clear to her. Her thoughts are suppressed even while her frustration is

spoken. This is important to her because her frustration is a sign that she feels out of control and that she and her daughter have no choices, but to follow stereotypical female behavior. She recognizes that her daughter will face many challenges if she pursues a predominantly male career, yet she is unclear as she speaks to the group as to why she is afraid for her daughter.

Upon further analysis, we can see silencing at work. She is expressing her frustration, but does not distinguish that her frustration derives from the fact that her daughter will not be able to stay within her socially defined boundaries and still achieve her dreams. How many more women are in this same situation due to their race, class, and sex combined with their gender? They too are silenced as they realize the social oppression which impedes their dreams and barricades them into a socially acceptable design with predetermined roles for their lives. The frustration of these women in not being able to achieve their dreams while in the socially labeled barricade is an undercurrent of this study that should be further explored with more research. Furthermore, it should be noted that some women may not feel frustrated or may not understand what they are feeling because they are not aware of the social boundaries holding them back. They are living beneath oppression in which they are unaware.

One example of this confusion and unawareness is that the participants seemed disturbed that the female scientists in the video were masculine and did not wear wedding bands. The worldview of these teachers shows conformity to the standards of what is acceptable for women. Due to social and unrelenting oppression certain female characteristics are accepted for women while male characteristics are not (Levit, 1998). Conformity to standardization of sex roles due to social oppression is addressed in

Critical Race Feminism (Delgado & Stefanic, 2001). "The sexual division of labor, so ancient that its unfairness is often accepted as normal, is an example of oppression" (Harding, 1987, p. 124). Critical Race Feminism and Feminist Theory equally teach that images of reality have the influence to form reality (Levit, 1998) and this reality is often oppressive. The female participants have been misinformed by images of reality in society to judge that all women should look and act a particular way and anything else is unacceptable and disturbing.

The participants' comments on the masculinity of the women, discussions on career barriers, comments on being "weird" if you don't follow the rules of society all point to their discomfort with others who are outside the margins of what they consider acceptable roles for women. I believe they wish for the social oppression and constraints to be removed. However, they are uncomfortable with the thoughts of having social controls removed because they do not want the social consequences that accompany the freedom. The shackles of conformity are comfortable as that is what they are accustomed to wearing in society. Without them they feel awkward and uncomfortable. Gender role conformity is an early life lesson, as girls and boys learn what is acceptable in society and are rewarded for staying within their boundaries and punished for crossing them (Kite, 2001).

Conformity is also a possibility in our group dynamics as the women may have appeared to change their minds or attitudes as a way of just conforming to the group. Although their stories are narratives of their lived experiences, they may have just detailed them in different ways to fit into the group's discussion. Conformity is difficult

to recognize as sometimes the ones conforming are not aware that they have given up their choices. Conformity is a significant practice that takes away power and choices.

### Significance of Stories

Foremost, the stories mean a willingness of the women to share their lived experiences with others. This willingness shows a desire to expose what may have been dormant for years. The stories reflect a white woman's interpretation of her experiences and her perspective of the world as a white, middle class, female. The unique experiences of each woman can be blended into the common theme of silencing which is attributed to intimidation, learned helplessness, and hopelessness. It is critical to the women in my study and women in general as these forms of oppression form a greater link of no confidence. Their lack of confidence contributes to the additional theme, which centers on the lack of opportunities. These women yielded to stereotyping and oppression in society and experienced less choices and opportunities in their lives. Critical Race Feminism upholds the interest of feminists to name gender oppression occurring in a patriarchal system (Wing, 2003). Social identities formed through these societal oppressions forced these women into a predetermined social location based on their race, class, and gender (Harding, 1991). Both Feminist Standpoint Theory and Critical Race Feminism name oppression and endeavor to combat sexism which occurs through oppression and stereotyping (Cleveland, 2004; Wing, 2003). The use of a Consciousness Raising focus group is a move toward "collective action to combat shared oppressions" (Levit, 1998, p. 149).

"We did what we had to do," was a comment made by Andrea, but resounded as a theme of oppression and stereotyping in the stories that other women shared. The women

seemed unaware of the meaning of their stories, but as they started to share them with the group a few of the participants began to see reasons for their experiences. The comments of the other women such as, “Naturally, you are a woman” and “Of course, that’s what girls have to do” and “You had no choice” served not only as support to the woman sharing the story, but served as a eye-opener to help the others begin to experience the meaning of their narratives in relation to their lives.

Nevertheless, it is significant to note that not all of the teachers could name detailed experiences in the science classroom that led to their beliefs. The lack of precise details speaks volumes to me. The fact that the teachers knew biases occurred, and the boys were favored in the class, but could not name specifics is significant as it names the slight, subtle, yet powerful barriers which existed in the lives of these teachers. This type of subtle oppression is ubiquitous and commonplace. Automatic, unnamed, pervasive, subtle, daily oppressions which often occur outside conscious awareness are termed as microaggressions and are discussed in Critical Race Theory (Solorzano, Ceja, & Yosso, 2000; Kesson, 2004; Snyder, Peeler & May, 2008). “Critical race theorists maintain that prejudice merely goes underground and then arises in small, covert acts of discrimination” (Kesson, 2004, p. 155). The teachers shared lived experiences where they were oppressed and stereotyped, which were microaggressions limiting their choices. This type of subtle oppression continues to exist today; as such feminists must continue social activism measures to bring what is hidden to the surface.

The teachers could visualize the barriers to their own desires, and the favoritism that the boys received. They knew the walls were there, but because they were built ever so slightly they had a difficult time recalling major, blatant experiences which



constructed them. Upon closer inspection they noted fallacies and inequities in their science experiences. Teachers recalled that the boys didn't need to work as hard for a passing grade. Comments such as, "I'm a girl and they know it and they treat me differently!" describe the overall classroom atmosphere. Some experiences were almost too subtle for them to name, until someone else pointed it out and said, "Hey, take a look at that!" It was at that point the teachers began to awaken as if a new seed had been planted, requiring the continuous watering of reflection and discussion. The support of the group provided the "pointing" and the naming of the inequities in each other's lives.

As teachers discussed the video and contemplated what they had viewed, they became more confident to open up and share their own opinions and experiences. During the C-R meeting, feminine voices filled the room with anticipation and fervor, as the teachers reacted positively to the message in the video. They were extremely eager and enthusiastic to begin their conversation about the video. An important finding from this conversation is that as members of the group shared their private experiences other members recognized the commonality, and the group formed a cohesive stance naming inequalities in their lives.

With this awakening, the teachers began to break through brick mortar as they began to realize how they have tolerated sexism on a daily basis resulting in feelings of intimidation, hopelessness, stereotyping, loss of opportunities, and ultimately silencing. Additional memories and opinions spawned as a result of the on-going, fervent discussion. The camaraderie in the group formed after viewing the video, and the teachers began to share experiences of gender biases. They seemed to find the voice that had been silenced in the past.

The teachers in the group responded enthusiastically to the new information in the video and to the stories they shared with each other. Feminist Standpoint Theory reminds us that the views of my participants are partial and biased and their knowledge is socially situated (Harding, 1991; Haraway, 1988). However, the participants in my study offer a favored view as they have a subjugated standpoint, a view from below, which aids in our understanding of power structures in society, schools, and science.

Critical Race Feminism adds to the framework by acknowledging the whiteness of their feminine views as all participants are white women. The unique views at the intersection of white, middle class, and female, provide a view from a particular social location of these teachers. This adds to the uniqueness of my study. Their experiences are unique based on their social location. Additionally, Critical Race Feminism addresses power issues and is concerned with who has the power and how power is wielded especially in oppressive educational and legal structures (Cleveland, 2004; Wing, 2003). The combination of Critical Race Feminism and Feminist Standpoint Theory recognizes the intersection of the unique experiences of white women in an oppressive educational system. Both theories are crucial in this study to assist in naming oppression and stereotyping that occurred in the lives of these participants in the form of male domination, sexism, and oppressive educational experiences.

My study sheds light on the darkened recesses of the feminine mind where walls have been built and their voices have been silenced. Places where subtle barriers and injustices have blocked out reality. Being taught one “truth” and experiencing another, female teachers have accepted god-like science and not trusted what they know based on

their own experiences. The video helped remove the bricks in the wall allowing the teachers to view oppression which exists not only in science, but in society as well.

Participants were able to name experiences which describe silencing of intimidation, learned helplessness, and manipulation. They shared stories of loss of opportunities in the classroom and in career choices due to stereotyping. Additionally the participants were able to assimilate the hegemonic message of science applying it to lived experiences in the classroom and society. These themes are important as they expose deeper feelings of inferiority, low self-esteem, and lack of power in their own lives. As they shared, the females became empowered and confident to embark on naming oppressions and limitations placed upon them. Due to oppression and social conformity, many of the participants had submitted unconsciously to their own domination by the culture of power. Nonetheless, my study provides an avenue for some female science teachers to better understand their lived experiences and empowers them to not perpetuate the cyclical sham of science.

#### Recommendations for Future Research

My recommendations for further research center on studying the lived experiences of teachers and subsequent impact on their current practices and beliefs. The teachers in the focus group are just beginning to scratch the surface of critically analyzing their experiences. In fact, some seem to be on the border of actually recalling and analyzing experiences, but I question if they will apply their analysis to current pedagogical practices. Will they continue to teach in the same manner in which they have taught or will they change their practices? Will they be able to not only name experiences from their own lives, but support students in naming social constraints due to

manipulation, socially defined gender roles, and hegemonic practices in schools and society? Further research is needed to answer these questions.

A longitudinal study to address these changes would detail current practices in the classroom and how they are impacted by the Consciousness Raising focus group. A mixed study combining an ethnographic approach using participant observation and a focus group would allow for tracking changes in practices and beliefs. The ethnographer would observe the participants prior to the meetings to collect data on current practices. Then the group would meet monthly for teachers to discuss past and recent experiences in and out of the classroom. Afterwards, each teacher would be observed by the ethnographer to collect field research. Meetings and participant observations would alternate to observe how the group meetings influenced current practices.

Another avenue for further research should be focused on critically analyzing lived experiences of female science teachers to examine how lived experiences form their current beliefs and practices. Gender is a dominant basis determining the lived experiences of female teachers and their current practice (Smulyan, 2000). Science teachers' decisions in the classroom are based on what they have experienced in their own lives and how they have made sense of those experiences (Halai, 2004). Further studies are needed to assist teachers in becoming more critically aware of their own biases based on prior experiences, so they will not continue to promote social injustices within the classroom.

I suggest future research is needed with participants representing racial and class diversity. My study had a lack of racial and class diversity due to the potential subject pool being too homogenous. A diverse group of participants could provide a multiplicity

of views derived from a unique set of experiences at the junction of their race, class, and gender. A study with these people groups included would provide a better view of hegemonic power structures in society.

### Strengths and Limitations

I acknowledge my standpoint as a white, middle class, female teacher limits my view and understanding of others with dissimilar standpoints. “Who we are as people shapes what we can know; and how we go about knowing shapes us as people” (Conle, 1999, p. 8). However, this should be named as one limitation of my study. The racial and class make-up of the group was similar to my own. My white, academic, middle class privilege all contributed to my understanding of the views of the participants who all shared in the same privileges. I most likely felt that I understood their views too well, and thus did not press for additional details or clarification from them. They were expressing views comparable to my own. My group and I shared a similar standpoint. However, by starting research from the lives of others even if we have similar backgrounds, I gain an enhanced insight to their lived experiences and how they derive meaning from their experiences.

The use of Consciousness-Raising groups is in some ways a strength of my study and in other ways it is an additional limitation of my study. The group served as a support to each participant allowing her to recall experiences and share those experiences with others. Many participants were able to name for the first time gender biased experiences which have occurred in their lives. The focus group served as a way to open avenues of conversation and thought individually and collectively. The data from the focus group was rich and detailed, not impersonal or cold. The stories of others allowed us an intimate

snapshot of events that have occurred in these teachers' lives. However this same rich data collected from the C-R group reminds me that there is no complete understanding in the stories of others. Many of the participants may be agreeing with the group as a result of groupthink or due to my power as a researcher in the group gathering data. In this study it is not possible for me to know if their narratives and agreements with one another are a result of groupthink or a result of a new awareness. The teachers seemed to become more critically aware of their experiences as the group formed a mostly cohesive stance naming inequalities in their lives.

An additional limitation is the hardening of the stories in the retelling and the difficulty in summarizing and packaging a story (Conle, 1999). My interpretation and analysis of another's story is a limitation as it changes the story from its lived form taking on the life that I give it. My research cannot be objective in my attempt to recount and understand the experiences of another.

Another limitation of my study is the use of the video which gives only one view on the nature of science. Teachers can accept or reject the message, yet the message sent to them that science is a masculine, hegemonic construct assumes only one position and does not allow for multiplicity of views. Teachers were not presented with two arguments on the historical roots of science. They only received one view and were asked to comment on the message they received.

The use of a feminist framework is strength of my study as it allowed me to begin my research from the lives of those who are marginalized. As a feminist employing feminist pedagogy, I started my research from the lives of those marginalized, questioning their critical consciousness and awareness to challenge hegemonic practices

in society, schools, and science. Female teachers experienced social and political influences in their science education (Debacker & Nelson, 2000; Sonnert, 1995). Thus it is crucial to understand their beliefs and experiences from their own standpoint. My theoretical framework allowed me to do so.

### Summary and Conclusion

Using the lenses of Feminist Standpoint Theory and Critical Race Feminism allowed my study to challenge the objective claims of science and address the intersection of race, gender, and power relationships. Mayberry and Rees (1997) assert that feminist pedagogy makes a commitment to the development of a critical consciousness to apply knowledge to social action and change.

Science gender equity research unveils teaching practices that support males and impair female successes (Tindall & Hamil, 2004; Sadker & Sadker, 1994). Thus, it was essential for my study to offer the opportunity for female science teachers to name gender biased injustices that are based on their lived experiences. By providing spaces for these teachers to recall and share inequitable experiences, conversations regarding social inequities have been promoted.

I ask myself, “What is the purpose of research and curriculum inquiry if is not to engage in intellectual conversations to enhance the lives of all? Where is my voice in this conversation?” The purpose of my study was to make an educational impact on the lives of others through exposing the hegemonic nature of science and asking female science teachers to reflect on this message and on their past experiences. Inquiring into the lives of teachers, I have gained a clearer understanding of their standpoints, and mine as well. I believe now that teachers have critically reflected upon the nature of science and their

experiences that they will continue to become more conscious of the patriarchal, hegemonic nature of society, schools, and science.

I believe that the seed was planted for teachers to further nurture and investigate their newfound knowledge. The light has been shed on areas of their lives which have been darkened and closed due to subjugation and subtle barriers that they did not realize existed. Now that they have been exposed to hegemonic power structures that exist, I believe in the future they will be more able to name possible power structures in society and schools. They will recall stories, conversations, and perceptions that were shared during our focus group meeting. The teachers will not forget the day that they had a moment of critical awareness, just as I will not forget the classes and professors who spurred me to continue to search and question the powerful influences in my own life. The change in thinking may not occur immediately, but the seed for new thoughts has been planted and hopefully will grow through reflection.

Once a light is shed even if we return to darkness accepting societal influences, the memory of the brightness still exists. With knowledge of the former brightness, we will continue to seek its warmth and truth despite the pressures continually working against us. Turning back to darkness and despair is usually not an option, unless one chooses to discount what they experienced. I believe the female teachers will persist in deliberating and raising their awareness of subtle societal influences that stripped them of making their own choices. Hopefully, they will discuss with others their critical consciousness and begin to verbalize inequalities and name social oppressions as a way to strengthen their own awareness and open the eyes of others who have been blinded by subtle influences.



Curriculum studies requires us to explore teaching and learning throughout lifespans and contexts of experiences and to extend our own perspectives beyond natural boundaries. Through my study, others will become more aware of how their experiences may uphold hegemonic, oppressive practices in society, schools, and science. Not everyone can acquire academic privilege, which is a college education, but those who do surely must affirm and accept others around them creating spaces whereby all have a voice, a standpoint, an opportunity for others to share their privileged knowledge. This knowledge must not be merely text that others read, but genuine experiences to share. This undertaking becomes an enormous one when words must be put to actions to bring affirmative educational and societal change.

How we teach science and what we claim to be scientific knowledge becomes of utmost importance in curriculum studies (Alters, 1997) and research shows that teachers' lived experiences, attitudes, and beliefs guide their practice in the classroom (Maher & Ward, 2002; Halai, 2004; Argyis & Schon, 1980). My study is important in the larger field of curriculum studies because it exposes and names the masculine hegemonic nature of science and gender biases which occur in schools and society as seen through the standpoints and experiences of female science teachers. It has the potential of enlightening others that current science practices and "micro-inequities" in the classroom must be altered to include feminine thought and language. Through the voices of those often marginalized, social injustices are named, and others are invited to recognize a new standard which includes the standpoints of all.

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APPENDIX A  
INFORMED CONSENT

*College of Education*

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**COLLEGE**

*Curriculum, Foundations, and Reading*

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**DEPARTMENT**

**Date**

Dear \_\_\_\_\_,

My name is Tina Marie Wilkins, and I am a doctoral student in Curriculum Studies at Georgia Southern University. My proposed dissertation is entitled: *Unveiling the Nature of Science: A Journey into the Reactions and Reflections of Female Science Teachers*. I am interested in learning more about how female middle grades science teachers' will respond to a video about the hegemonic nature of science. As you know, Science is one area which females generally exhibit lower self-esteem and achievement. My dissertation purpose is to expose female science teachers to a video regarding the nature of science and collect their responses and any experiences which may surface after viewing the video. The benefits to participants will be an increased knowledge base on the nature of science, an opportunity to freely discuss opinions and reactions, and a chance to share prior experiences which may include subjugation or unfair treatment. The time required will be one session of two to three hours with a focus group.

This letter is to request your assistance in my dissertation research. I will ask interested teachers to answer a short on-line survey regarding teaching experience and beliefs. Teachers who return a completed survey will then complete a short informal

phone interview. Selected teachers will then be invited to participate in a small focus group of 8-10 teachers. The group will meet one evening for approximately two hours to watch a video on one view of the nature of science and then discuss the message in the video. An optional follow-up meeting will be conducted one week later to discuss any additional comments that may have arisen during the week. Data collection will take place in February, 2008.

I will ensure confidentiality for all participants by using pseudonyms for teachers' names and their schools. Additionally, participants will be protected by fictionalizing the sites where their experiences occurred and by writing their reflection in a novel-narrative style. Teachers have the right not to answer questions, as well as the right to withdraw from the research study at any time.

Teachers have the right to ask questions and have those questions answered. If teachers have questions about their rights they may contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-681-0843.

I appreciate your consideration of my request. Please sign below to acknowledge your decision to participate in my focus group research study. Please keep a copy for yourself and mail the original copy to me in the enclosed envelope. I would like to conduct my focus group on \_\_\_\_\_.

If you have any questions regarding my research, feel free to contact me, Tina Wilkins at 770-516-7590 (home), 404-277-2307 (cell) or via email at [ttwilkins@comcast.net](mailto:ttwilkins@comcast.net). My supervising professor, Dr. Delores Liston at Georgia Southern University, may be contacted at 912-871-1551.

Thank you in advance for your consideration and assistance in my study concerning the nature of science.

Sincerely,

Tina M. Wilkins

Doctoral Candidate, Georgia Southern University

Please sign below and indicate your willingness to participate in my dissertation research which I have outlined above. Please keep a copy and return one in the envelope provided.

---

\_\_\_\_\_ Yes, I would like to participate in this study.

\_\_\_\_\_ No, I would not like to participate in this study.

---

Participant's Signature

---

Date

## APPENDIX B

### SCREENING PROCEDURES FOR POTENTIAL PARTICIPANTS

Potential participants for my study will be located by using a snowballing procedure to find women science teachers. I will use my personal contacts to spread the word of my study by telling others in my community about my dissertation topic to solicit responses from women who would be interested in being screened as potential participants. I will protect my study by ensuring that my potential participants are teachers whom I have not met or only have made their acquaintance. The participants will not be friends or other teachers with whom I work. My friends and I will contact other teachers regarding their interest in the study. We will ask interested teachers to contact me on my home email. When someone emails me expressing an interest in my study, I will email the Screening Survey consisting of three short questions regarding teaching experience.

How many years have you taught science?

What grade levels have you taught?

In which of these grade levels did you teach science?

Teachers who return the completed survey and have three years experience teaching science in middle grades will be contacted by phone to confirm their interest in the study. I will ask her if she is willing to watch a short movie that presents one idea of the nature of science and share her reactions in a small focus group comprised of middle grades female science teachers.

Once I have screened all potential participants, I will choose eight to ten teachers for the study. The teachers included in my study will be those who have a minimum of

three years teaching science in middle grades, appeared to be comfortable chatting informally with me on the phone, and expressed a willingness to view a video and share her opinions on one idea of the nature of science.

## APPENDIX C

### POSSIBLE GUIDING QUESTIONS

I would like to explore the teachers' understanding of the message in the video of the hegemonic nature of science, and any experiences which may have surfaced as a result of watching the video or participating in the C-R group.

Personal Understanding and Experiences:

What is your understanding of the message in video?

What does it mean to be a female science teacher?

Are there differences between men and women in regards to science teaching and learning?

Can you name experiences which you believe may have led to you having these opinions?

What are your views on the nature of science?

Do you believe science is a problem for females?

Do you have any personal experiences to share which support your beliefs?

Do you think these experiences are important to you today?

What people have negatively and positively impacted you in developing your attitudes toward science?

Has anyone or any situation specifically influenced your thinking regarding science education and practice to challenge your thinking?

Can you think of any other types of experiences which you may want to share with me?

APPENDIX D

OPINIONS PRIOR TO AND AFTER C-R EXPERIENCE

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I think science is objective.					
2. I am confident that science is free from social constraints.					
3. I know science does not have any subjectivity in it.					
4. Science is not biased.					
5. My experiences in science class were equal to the experiences of male students.					
6. I enjoyed all of my science classes in middle school through college.					
7. My science teachers treated male and female students equally.					
8. I recall mostly positive experiences in my science education.					
9. I enjoy science.					
10. I enjoy teaching science.					



## APPENDIX E

### DATA ANALYSIS SPREADSHEET

Categories will be developed based on the data. These are a few of the potential predetermined themes.

	Contradictions of self	Body Language of participants when they share ideas	Gender/Sex narratives of participants	Career Choices	Narratives from school experiences as a student	Narratives from school experiences as a teacher
Participants						
A						
B						
C						
D						
E						
F						
G						
H						
I						