The Novice and the Expert: How Gender and Experience Influence Student Participation, Interest and Learning in an Internet-Based Science Project

by

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B.S., B.A. Vanderbilt University, 1992

A thesis submitted to the
Faculty of the Graduate School of the
University of Colorado in partial fulfillment
of the requirement for the degree of
Doctor of Philosophy
Department of Education
2003

UMI Number: 3087571

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

This thesis entitled:

The Novice and the Expert: How Gender and Experience Influence Student Participation, Interest and Learning in an Internet-Based Science Project

written by Megan Mistler-Jackson

has been approved for the Department of Education

Chair of Committee

Committee member

Date 4/15/03

The final copy of this thesis has been examined by the signators, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

ABSTRACT

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The Novice and the Expert: How Gender and Experience Influence Student Participation, Interest and Learning in an Internet-Based Science Project
Thesis directed by Professor Ronald Anderson

The purpose of this study is to examine how gender issues influence middle school students' participation, interest and learning in an Internet-based science curriculum project. One central question is whether using the Internet for communication and collaboration might serve as an entrée into science and computer technology for those who are otherwise disinterested. Five students and their teacher were observed for five weeks and interviewed at the end of their participation in the Journey North Internet-based science project. Other methods of data collection included field notes, journal writing, and document review. Data were analyzed using ethnographic and case study methodology. Results revealed that boys were viewed as science and computer experts by themselves and by their peers more often than girls, both when they were and were not more knowledgeable. Data also showed that the teacher's inexperience with computers and the Journey North project was a more significant factor in student learning than gender. Findings with two students support the notion that using the Internet for communication and collaboration may encourage participation in computer technology by students like them. These results add to literatures that document the gender gap in science and computing and complement research on the incorporation of the Internet in the classroom. This study examines participation and interest from students' points of view, confirms the central role teachers play in enacting network science projects effectively and identifies several challenges this teacher faced in learning to utilize new technologies.

DEDICATION

For Lindsay and Luke -

May you find open doors on your journey through life.

ACKNOWLEDGMENTS

First and foremost, I must thank my husband Jeff, without whom I could not have completed this dissertation project. With at first one, then two small children, his partnership in parenting and support for my work has been steadfast and invaluable.

I also appreciate my father's financial support and emotional encouragement over the years. His commitment to education and his encouragement to pursue my interests and achieve my potential have helped shape my life. My mother's independence and progressive attitudes have also influenced my interests and her support during the data collection phase of this project was invaluable.

I would also like to thank Laura who volunteered out of the goodness of her heart to participate in this research project. Without her, I would not have accomplished this work as soon or as easily. Her involvement was instrumental in my completion.

My committee members spent numerous hours reading drafts and each provided meaningful comments that contributed positively to this learning experience. I appreciate their professionalism and collaborative approach throughout the process. Special thanks to Ron Anderson, my adviser, for his positive feedback and support for my personal as well as professional life. Special thanks as well to Jeff Frykholm and Steve Guberman who read additional drafts above and beyond the call of duty and pushed my thinking.

I also need to acknowledge my friends and colleagues who have encouraged and taught me throughout my graduate school experience. Special thanks to Janet

Powell whose lasting friendship and mentorship provide a safe haven for asking questions and confidence in my future. Thanks also to Nancy Songer, Jenifer Helms and Jeff Swink with whom my learning experiences have shaped my professional interests.

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CHAPTER 1: THE RESEARCH PROBLEM

Introduction

The purpose of this study is to examine how gender issues influence middle school students' participation, interest and learning when participating in an Internet-based science curriculum project. This study is based on prior research that documents a gender gap favoring males in science and computer technology interest and achievement (American Association of University Women, 1998, 2000; National Center for Education Statistics, 1999). Adolescents are of particular interest because during the middle school years, students become increasingly aware of these gender gaps and often make choices according to what their peers define as appropriate (Brown & Gilligan, 1992; Orenstein, 1994; Pipher, 1994). Identification of science and computers as masculine often leads girls to opt out of pursuing science and computer technology during the high school years (American Association of University Women, 1998, 2000). Efforts are being made to reduce the gender gaps in these fields in tune with the goals of the current reform movement in science education to make science accessible to "all" students (American Association for the Advancement of Science, 1990; National Research Council, 1996).

The advent and incorporation of new computer technologies into our classrooms is creating uncharted territories that are ripe for research. In particular, it is important to understand how the use of computer technology is influencing student learning and participation. It is also important to understand the benefits and drawbacks of the use of various technologies for various students. Computer technologies vary tremendously in their purpose, content, and appeal to individuals (American Association of University Women, 2000; Schofield, 1995). The Internet is broadening the scope of what can be done with computers in and outside of school (Turkle, 1995). Some researchers indicate that the Internet culture is more inclusive than the larger computer culture that came before it (Furger, 1998; Turkle, 1995). Therefore, a timely question in educational research is whether the use of the Internet for communication and collaboration serves as an entrée into the world of computer technology for those who would otherwise be disinterested. Additionally, because the use of computer technology in the science classroom combines two areas that have traditionally been considered masculine, does this combination perpetuate the gender gap in science? Or, does the use of the Internet for communication and collaboration spark the interest and participation of students normally disengaged? If so, does its incorporation into the science curriculum provide new opportunities for students to become engaged with science? There is such a small amount of research in this area that there are calls for studies to address any number of questions related to the use of Internet technology in the classroom (American Association of University Women, 1998; Anderson & Krajcik, 2000; Windschitl, 1998). Therefore, this study examines the use of the Journey North Internet-based science project in one middle school science classroom to understand how it influences student interest, participation and learning in that classroom setting.

This chapter provides a general background for the overarching research problem that there are significant gender differences in science and computer technology interest and achievement. Chapter 2 describes the conceptual framework used to guide the development of research questions and foci for interpreting data for this research. Chapter 3 provides the methodology for the study. Chapter 4 presents the findings from the data and addresses each research question. Chapter 5 discusses the conclusions of the study and their significance, as well as implications, limitations, and questions for further research.

The Status of Gender Equity in Science Education: The Big Picture

Science education reform literature of the past decade has set forth the goal of 'science for all' with the desire to increase the scientific literacy of the population and to retain a wider range of students in the sciences (American Association for the

Advancement of Science, 1990; National Research Council, 1996). This goal has been spurred by disappointing performances on national and international assessments and by disparities in participation and achievement between white, middle and upper class males and other populations of students including females, students in lower socio-economic brackets, and those of non-white ethnicities.

While the validity and meaningfulness of standardized tests are debated, they still drive the overall achievement picture locally, nationally and internationally. The Denver Post reported the 2000 CSAP results in Colorado with the headlines, "55% of 8^{th}-graders fail CSAP science exam" (Ednalino, 2000, p. 1A). The paper reported that boys outperform girls, that white students outperform those in other ethnic groups, and an overview of statewide scores reveal striking differences along SES lines. 1996 National Assessment of Educational Progress (NAEP) data indicated that boys received a larger proportion on the highest science scores beginning in fourth grade and the gender gap increased in the eighth and twelfth grades (American Association of University Women, 1998). The Third International Mathematics and Science Study found that the United States was one of 10 countries, out of 26, with a gender gap favoring males in fourth-grade science achievement, and that male twelfth-graders outperformed their female counterparts in general science knowledge and physics (National Center for Education Statistics, 1999). While they found that the gender gap in eighth grade science achievement was not significant (National Center for Education Statistics, 1999), the 4^{th} and 12^{th} grade differences and data from other studies suggest that a gender gap remains a real and persistent issue in science education. The American Association of University Women (1998) suggested that any gender gap in achievement exacerbates the decline in United States performance over the years:

> The United States was above average in math/science performance at the fourth-grade level (when gender differences are nonexistent), average in performance at the eighth-grade level (when gender differences, at least in science, become more pronounced) and substantially below the international average in math and science performance by the twelfth grade (when gender differences were marked in the United States and internationally) (p. 32).

Therefore, the American Association of University Women (1998) pointed out that reducing the gender gap is crucial to raising overall performance and achieving the sought-after high standards for all students. However, we currently face a situation in which "females are the only group in America to begin school testing ahead and leave having fallen behind" (p. 136, Sadker & Sadker, 1994).

While the previous standardized tests show that boys score better than girls, the overall achievement picture is more complicated. Girls receive higher grades than boys in all subjects, including science, across all grade levels and in college. SAT scores that are designed to predict freshman academic performance tend to underpredict girls' college performance (American Association of University Women, 1998). There is an Advanced Placement exam paradox as well. Girls take AP courses and the corresponding tests in greater numbers than boys in English, social studies, foreign language and biology, but earn lower scores than boys in all categories except foreign language (American Association of University Women, 1998). More boys take the tests in science, calculus and computer science and there too earn a greater proportion of scores 3 and higher than girls (American Association Of University Women, 1998). There are varying explanations for these discrepancies ranging from test bias to differential testing strengths (multiple-choice vs. essay) to grades based on effort and behavior as well as performance. Whether test scores or grades are the better measure of success are continually under debate.

Equally important to standardized test achievement is an examination of differential course enrollment patterns among boys and girls in high school science. Greater percentages of female high school students are enrolling in science courses today than a decade ago, but boys still complete the maximum course sequence (biology, chemistry and physics) in greater numbers than girls (American Association of University Women, 1998). This is largely due to physics in which a significant gender gap persists. In fact, more girls enrolled in biology and chemistry than boys in

1994, but since so few enrolled in physics, the overall numbers still favor boys (American Association of University Women, 1998). But, as stated before, high school males are more likely to take AP courses in all science subject areas except biology. As a result of these differential course-taking patterns, males are more likely to continue in the sciences in college and beyond, and the greater number of male engineers and scientists reflect this pattern (American Association of University Women, 2000).

Speculations as to why white males dominate secondary and post-secondary science courses and science-oriented careers have varied including curriculum and instructional methods that alienate women and minorities; teacher bias toward white males that stems from subconscious and conscious beliefs about ability; and entrenched beliefs about the nature of science as a field that requires characteristics such as objectivity and rationality that are attributed to males more than females. As will be presented in the conceptual framework, research on classroom interactions, psychological and cultural influences on students, adolescent struggles with identity development, and feminist critiques of science help illuminate the discussion of male dominance in the sciences.

Many members of the science education community realize that it is to the benefit of students and society to reduce or eliminate these discrepancies in course taking patterns and career choices of females and minorities. Arguments in favor of equalizing educational outcomes range from the practical to the philosophical. Practically speaking, science-related careers often bring a high standard of living that a wider portion of the population should be able to compete for. Additionally, scientific research may benefit from the perspectives of a wider range of scientists working to identify research problems and interpreting data. Philosophically, when denied full participation in all endeavors, people are unable to fulfill their potential and experience the fullness of humanity.

So, as the prior data suggest, there is a real and persistent issue regarding gender differences in science achievement that merits further research. There is a myriad of ways to view gender issues in education, and the framework for this study represents a focus on educational equity. The 1998 American Association of University Women report, *Gender Gaps: Where Schools Still Fail Our Children,* defined equity as a concern for unequal educational outcomes by social background (i.e. gender, ethnicity or socio-economic status). The report distinguished between equity and equality, a distinction that has important ramifications. If the concern is equality, the question is whether students receive the same education. If the question is equity, the concern is whether students receive the "right education to achieve a shared standard of excellence" (p. 3). That means that students may need different things to achieve the same outcome. A focus on equality leads to a deficit model interpretation of why students don't perform as well as others. If all students receive the same science education, those lagging behind need to "catch up" with the standard set by white males. A focus on equity looks to institutional shortcomings and the differential strengths and interests of those who have been shortchanged and seeks ways to modify the culture and practice of education to better meet the needs of all learners.

Furthermore, the report stated that equity implies quality education for all students. It is aligned with the current standards reform movement in science education in this goal. As stated before, where gender gaps are pronounced, overall achievement suffers. The 1998 American Association of University Women report contends that there is an inherent and crucial link between the achievement of equity goals and the achievement of high academic standards for all students.

> In many respects, the two movements seek the same objective: educational outcomes that don't vary by gender, race, class or ethnicity. Standards propose that all students can succeed, no matter how disadvantaged or challenged they are. Similarly, the equity agenda proposes that educational outcomes need not be determined by social background. Indeed, by definition, an inequitable education (one that produces uneven achievement for some groups- for example, girls in science or math) falls short of the standards movement goal of comparable – and high – level of achievement for all students (p. 6).

These same concerns can be applied to gender gaps that are also pronounced in the use of computer technology and the pursuit of computer science education and careers.

The Status of Computer Technology in Education

> The question is no longer whether computers will be in the classroom, but how computers can be used to enhance teaching and learning - ideally, in ways that promote the full involvement by girls and other groups currently underrepresented in many computer-related endeavors (p. ix, American Association of University Women, 2000).

Studies of the use and efficacy of computer technology in supporting education are important and timely. The prevalence of computer technology has proliferated in classrooms around the country over the past two decades and its practical applications are expanding with increased speed, development of educational software, and the Internet. As a result of the demands of our technological society, there is a national consensus that computers have an important place in education.

Studies have shown that most students have positive attitudes toward computers and that the use of computers contributes to increased motivation (Lenk, 1992; Huber & Schofield, 1998; Mistler-Jackson & Songer, 2000; Schofield, 1995, Software Publishers Association, 1995; Songer, 1996, 1998; Wallace, Kupperman, Krajcik & Soloway, 2000). Whether this increased motivation corresponds to improved learning is unclear, but the potential exists (Schofield, 1995).

However, access to computers, especially high quality computers, is still divided along socioeconomic lines. Low-income students and children of color have the least access to computer technology at school and at home. Whites are two to three times more likely to have a home computer than African-Americans or Hispanic Americans (Furger, 1998; Schofield, 1995). While most schools have computers due to the national push to purchase them, students in smaller schools and those in affluent areas share newer computers with a fewer number of other students than students in large, urban or rural schools (Furger, 1998; Johnston, 2001). Additionally, students in lower socio-economic areas or in schools with predominately minority enrollments use computers for drill-and-practice activities most frequently (Reid, 2001). In contrast, students in affluent areas have more opportunities to use computers creatively such as for Web design and multimedia presentations (Reid, 2001). These discrepancies shape the quantity and quality of experience that different groups of children have with computers. And, prior experience with computers has been shown to be a key factor in subsequent confidence and competence with computer technology (American Association of University Women, 2000; Furger, 1998).

Gender and Computer Technology

The bulk of computer technology equity research has explored gender differences among white, middle class Americans in computer use, interest and achievement. As with science, there is a significant gender gap favoring males, a gap that is most pronounced in advanced computer science coursework. Computer science is the study of computer design and programming, and it is often placed within the math department in high schools around the country (American Association of University Women, 2000). More boys take computer science courses in high school while more girls take clerical and data-entry courses (U.S. Department of Education, 1995). Additionally, boys take the computer science Advanced Placement Exam in far greater numbers than girls, and the girls who do take the exam earn scores of 3, 4 or 5 less frequently than boys (American Association of University Women, 2000). More specifically, 91 percent of the test-takers for the Advanced Placement Exam in 1999 were boys (American Association of University Women, 2000). And, 17 percent of the boys who took the exam received the highest score (5), versus 10 percent of the girls (American Association of University Women, 2000).

The current characterization of the gender gap focuses on girls' disenchantment with the computer culture, which, like science, is identified as a male domain (American Association of University Women, 2000). This stems from qualitative studies that indicate girls think computers are a useful tool, enjoy using them and feel competent with them, but do not seek them out as companions, friends or toys (American Association Of University Women, 2000; Schofield, 1995; Turkle 1984, 1995). This is in contrast to boys who are more likely to spend more time playing with computers and maintaining an interest in the machine itself, beyond its usefulness as a tool (American Association of University Women, 2000; Schofield, 1995; Turkle 1984, 1995). Girls have expressed distaste for boys' intimate relationship with computers and maintain an "I can, but I don't want to" attitude toward participation in the computer culture (American Association of University Women, 2000). Theorists maintain that this difference is due to the way society constructs computers as a male domain and in turn sends differential expectations to boys and girls. These types of gender expectations appear to be particularly poignant for adolescent girls who are struggling to define their identities in the midst of intense peer pressure to conform to accepted norms of behavior. Such norms for femininity often include deference to males in areas considered masculine.

In one classroom study (Upitis, 1998), the researcher sorted students into various categories, one named "hackers," to represent students who were particularly adept at using computers and problem solving. One girl in the class met all the criteria of being a hacker, but she was not included in the group because neither she, nor any of her classmates, viewed her as competent as the boy "hackers." This small anecdote helps illustrate how members of society accept computer technology as a male domain and send messages to girls about their abilities and place in a technological world.

Other studies suggest that boys tend to have a more comfortable relationship with computer technology than girls, based on participation in families and a society that affords boys more opportunities to interact with computers, tinker with them, and "create" on them (American Association of University Women, 2000; Furger, 1998). Girls are undeniably also using computers at home and in schools, but their interactions tend to be more limited in scope. For example, girls are less encouraged to tinker with computers and figure things out on their own, rendering them less knowledgeable and less able to view themselves as creators and designers of hardware and software than boys (American Association of University Women, 2000; Furger, 1998).

As opposed to a decade ago, computers are now infused across disciplines and therefore participation is not limited to computer programming. There is some debate as to whether new applications and new technologies will change the nature of the computer culture. For example, computer science courses and programs such as computer-assisted instruction, drill and practice, and word-processing have been around for some time, but Internet technology is new and dramatically changes the scope of what can be done with computers in school. Research has documented the masculinity of the computer culture before the Internet (Schofield, 1995), but there is disagreement on whether the Internet culture appears to be different (American Association of University Women, 2000; Furger, 2000; Turkle, 1995).

Some researchers have suggested that the use of the Internet positively changes the computer landscape for many users. The interactive nature of virtual communities transforms the computer from simply a tool into a more meaningful and interesting part of life (Turkle, 1995). Girls' participation in virtual communities has, in some cases, served as an entree into the world of computer technology (Furger, 1998; Turkle, 1995). Other research indicates no gender differences among student preferences and use of computer technology in the science classroom (Linn & Hsi, 2000). The American Association of University Women (2000) indicated that girls view the Internet as part of the larger computer culture, not separate from it. And while girls particularly enjoy using the computer for communication, the nature of the Internet, and boys' use of it, does nothing to combat what they see as the negative aspects of the computer culture (American Association of University Women, 2000). The American Association Of University Women (2000) has expressed concerns that while Internet technology is being touted as the great leveler in education across class and gender lines, its increasing prevalence may in fact further alienate some populations of students. Likewise, its prevalence in science may further exacerbate inequities along gender lines if the culture of science and computer technology remain the same.

However, given that girls suggest they enjoy using the Internet for communication and studies indicate many students show increased motivation when using computer technology, significant potential may exist for Internet-based science projects to positively affect girls' interest and learning in science.

Description of Study

As stated previously, the **purpose of this study is to examine how gender issues influence middle school students' participation, interest and learning when participating in an Internet-based science curriculum project.** This study focuses on the intersection of the scientific and computing cultures as they are manifested in a middle school science classroom setting. The choice of a middle school science classroom is significant since adolescent girls face pressure to conform to accepted definitions of femininity that often discourage girls from excelling in "masculine" domains. Qualitative research methods that help explore the complexities of students' experiences in this setting were employed.

The broad questions for this study fall under four main categories that are derived from the upcoming conceptual framework.

- How does the culture of the classroom influence girls' and boys' participation, interest and learning?
- How do issues unique to adolescent development inform girls' and boys' participation, interest and learning in the classroom?
- How is the scientific culture manifested in this classroom setting, and how do students' views of it influence their interest, participation and learning with the curriculum?

- How is the computing culture manifested in this classroom setting, and how do students' views of it influence their interest, participation and learning with the curriculum?

CHAPTER 2: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Introduction

The conceptual framework for this study is comprised of four main categories that have implications for girls' participation, interest and learning in science and Internet technology. These include the influences of:

- The school and classroom culture
- Adolescence and gender
- The culture of science
- The culture of computing.

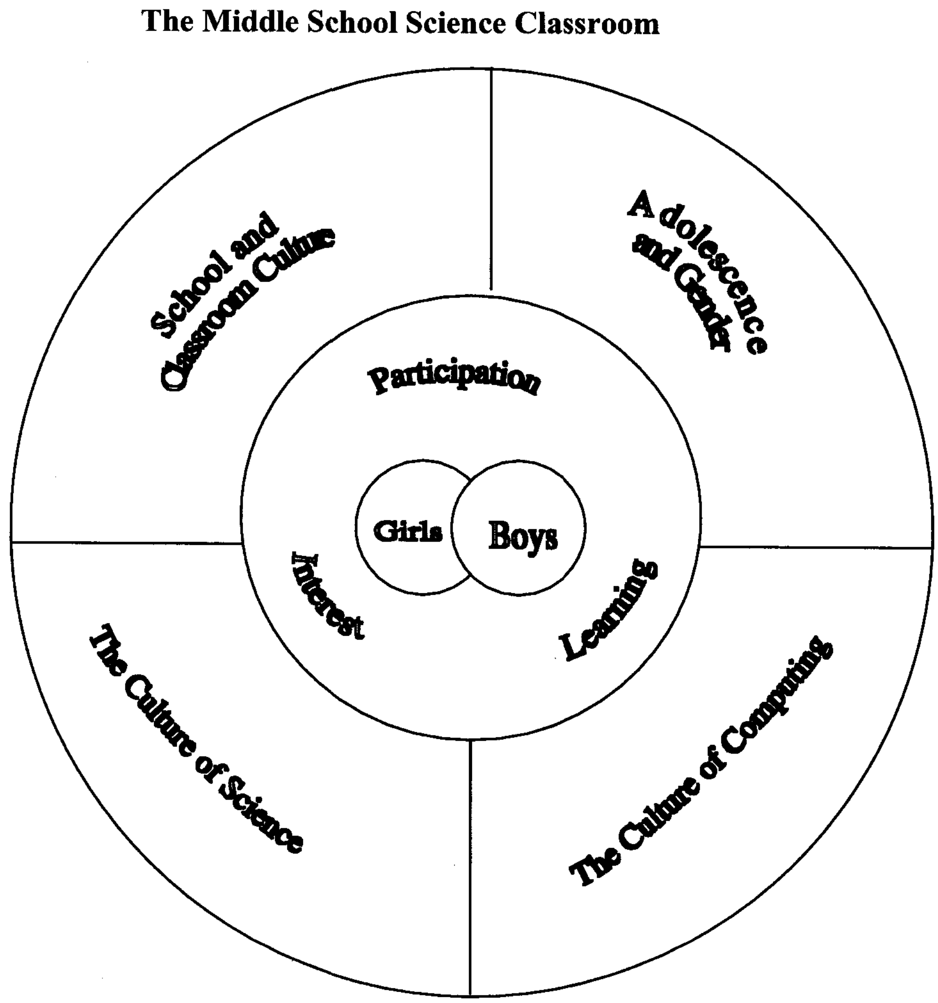
Some of the literature related to each of these categories comes from a psychological orientation, some from a cultural one. Both psychological and cultural frameworks offer important perspectives from which to explore how girls' experiences shape educational outcomes.

This framework suggests that students' experiences within the classroom setting, their experiences navigating the demands of adolescence, and their experiences negotiating a place in the scientific and computing cultures all come together as important issues when examining middle school students' use of Internet technology in the science classroom. Furthermore, girls face unique and significant challenges in pursuing science and computer technology education because of a cultural conflict between femininity and these 'masculine' domains.

The literature related to each element of this framework builds a case of a chipping away of girls' confidence during adolescence that is particularly pronounced in fields such as science and computer technology. The various forces of gender bias present in the classroom, cultural messages about femininity that girls often internalize during adolescence, and a conflict between feminine 'ways of knowing' and the dominant paradigms of the science and computing cultures combine to alienate girls who might otherwise be interested in science and computer technology from the confident pursuit of these fields. This literature also raises the question as to whether there is an Internet culture that differs from the larger computer culture. This question is central to the study as it aims to explore whether the use of Internet technology for communication and collaboration has the potential to serve as an entry point for some girls into the scientific and computing cultures because it is more closely aligned with feminine ways of knowing the world.

In the following visual representation of the conceptual framework, girls' and boys' participation, interest and learning in the middle school science classroom are imbedded in students' experiences with the four cultural and psychological influences listed in the outside ring. Each element plays a part in determining the level of boys' and girls' participation, interest and learning with the curriculum.

Figure 1: Visual Representation of the Conceptual Framework



The following literature review is divided into sections that address each of these categories. Each element of the framework carries with it a conflict or set of conflicts for girls that can undermine their successful participation, interest and learning in science and in the use of computer technology that becomes pronounced during the adolescent years.

Gender Issues in the Classroom

Classroom Culture

Research on classroom interactions among teachers and students and between students sheds light on the ways boys and girls can have quite different experiences in school. Most of the differences are subtle, some are blatant, yet both can be powerful in molding students' identities. Myra and David Sadker have spent several decades studying gender differences in schools. Their 1994 book, *Failing at Fairness: How our Schools Cheat Girls,* documented the variable treatment that boys and girls receive in the classroom. They noted that the differences are often so subtle and engrained in our culture that when others watch a classroom video full of gender bias, they don't see any of it until it is pointed out. Then participants in their workshops have an 'aha!' experience about what subtle gender bias is all about. The Sadkers also illustrated the gender bias pervasive in course materials and how significantly the images presented in these materials can influence students' perceptions of male and female ability. Additionally, parents play an important role in classroom culture through the expectations they maintain for their children and the ways they reinforce or challenge the gendered expectations students encounter at school. In sum, these various forces help create the particular culture of a classroom that, when biased against girls' full participation, can be detrimental to girls' academic and social development.

Teacher bias

> In my A.P. physics class in high school there were only three girls and twenty-seven boys. The three girls, myself included, consistently scored at the top end of the scale. On one test I earned a 98. The next closest boy earned an 88. The teacher handed the tests back saying, "Boys, you are failing. These three pretty cookies are

> outscoring you guys on every test." He told the boys it was embarrassing for them to be beaten by a girl (Sadker & Sadker, 1994).

Teachers play a central role in determining the climate of their classrooms. While most teachers are unaware that they treat boys and girls differently and some make a conscious effort to avoid gender bias, an examination of many classrooms reveals a subtle and pervasive gender bias that undermines girls' confidence. For example, Sadker and Sadker (1994) reported that boys call out responses more than girls and demand more of the teacher's attention. While teachers get frustrated with the calling out and set rules that students must raise their hands and wait to be called on, the girls are more often reprimanded for breaking the rule. They write that this "system of silencing operates covertly and repeatedly" (p. 43) throughout years of schooling and socializes girls not to be disruptive, aggressive, or demanding.

Boys' disruptive behavior is reprimanded, but expected, so it gets framed and tolerated differently by teachers than girls' disruptive behavior. Orenstein's (1994) qualitative study of adolescent girls provides many rich examples of some of the phenomena discussed more broadly in Sadker and Sadker's book.

> In mid-November, Mrs. Richter is giving out grades... The teacher sits at her desk in the back corner of the room, and the students come up one by one... When Dawn's turn comes, Mrs. Richter speaks sharply to her. "You're getting a B," the teacher says, "but for citizenship, you're getting 'disruptive.' You've been talking a lot and there have been some outbursts." Dawn scrunches her mouth over to one side of her face, lowers her eyes, and returns to her seat.
>
> "Disruptive?" yells Nate from across the room where the teacher's voice has carried. *She's* not disruptive, *I'm* disruptive." Mrs. Richter laughs. "You've got that right," she says. When his turn comes, Nate gets a B plus. "It would've been an A minus if you turned in your last homework assignment," Mrs. Richter says. As predicted, his citizenship comment is also 'disruptive,' but the bad news isn't delivered with the same sting as it was to Dawn – it's conferred with an indulgent smile. There is a tacit acceptance of a

> disruptive boy, because boys *are* disruptive. Girls are too, sometimes, as Dawn illustrates, but with different consequences. . . .
>
> Over the course of the semester, Dawn slowly stops disrupting; she stops participating too. At the semester break, when I check with Mrs. Richter on the classes' progress, she tells me, "Dawn hardly talks at all now because she's overpowered by the boys. She can't get the attention in class, so she's calmed down."
>
> Nate, however, hasn't changed a bit, but whereas Dawn's behavior is viewed as containable, the teacher sees Nate's as inevitable. "I'll go through two weeks of torture before I'll give him detention," Mrs. Richter says. "But you have to tolerate that behavior to a certain extent or he won't want to be there at all, he'll get himself kicked out" (Orenstein, 1994, p. 16-17).

As a result of different expectations, girls and boys learn what they can and can't get away with in class. Many girls learn the lesson that they are to be cooperative too well, and their education suffers because of it. Girls are often model students. They get better grades and receive fewer punishments than boys. Their good behavior allows the teacher more time to work with the more difficult to manage boys. As a result, girls receive "less time, less help and fewer challenges. Reinforced for passivity, their independence and self-esteem suffer. As victims of benign neglect, girls are penalized for doing what they should and lose ground as they go through school" (Sadker & Sadker, 1994, p. 44).

Girls are cognizant of these behavioral differences and often consider themselves superior to boys, especially at the elementary level (Sadker & Sadker, 1994). They complain that boys are more off-task, raise their hands even when they don't know an answer and dominate the class in inappropriate ways. This early confidence fades as girls progress through school. By middle school, many girls place so much importance on being correct and not looking foolish in class that they are afraid to be wrong. A female student in the gifted program at her suburban middle school explained, "Boys never care if they're wrong. They can say totally off-the-wall things, things that have nothing to do with class sometimes. They're not afraid to get in trouble or anything. I'm not shy. But it's like, when I get into class, I just . . . " She shrugs her shoulders helplessly. "I just can't talk. I don't know why" (Orenstein, 1994).

Because girls are often afraid of being wrong, they may take longer to respond to a question posed in class. This also works to their detriment as wait-time analyses have shown that teachers usually give students less than a second to begin to respond to a question. As a result, girls are often bypassed as boys are more willing to offer an answer (AAUW, 1998). Studies have also shown that boys are given slightly longer wait-times (AAUW, 1998; Sadker & Sadker, 1994), but the reasons are unclear. However, the message sent to students who are given more time to respond is that the teacher has confidence that they will get the answer right (Sadker & Sadker, 1994).

Girls are also sometimes the victims of blatant teacher bias. Blatant bias against girls is often most pronounced in science, math and technology classrooms in which some teachers believe that boys are more suited to excel in these fields than girls (AAUW, 1998). One student teacher told Sadker and Sadker (1994), "A lot of my female students complained about a science teacher who persisted in referring to them as 'dizzy' or 'ditzy' or 'airhead.' He often told the class, 'You can't expect *these girls* to know anything.'" A teacher from Louisiana told them about a science teacher who called the boys "Mr." or "Professor" but called the girls by their first names, if they were lucky, or "Blondie" (p. 95). There is a story of a girl in a high school chemistry class whose repeated question to the male teacher was ignored until he threw a beaker at her and yelled, "What do you want?" Afterward, he told the researcher that girls aren't suited to do science (Sadker & Sadker, 1994).

The American Association of University Women's (AAUW) Educational Foundation has spearheaded several landmark publications synthesizing the literature regarding girls' experiences in schools. Their 1998 publication, *Gender Gaps: Where schools still fail our children,* sought to examine the progress that had been made in the 1990s to reduce gender differences in educational outcomes. While there were some signs of improvement, they noted that studies of teacher-student interactions continued to document male domination in the classroom in both large and small groups. The most notable inequities occurred in math, science and technology classrooms.

What is the root of teacher bias? These inequities are not surprising when one considers the cultural bias at work in which girls are expected to excel in the humanities and boys in the sciences (Kahle & Meece, 1994; Orenstein, 1994; Sadker & Sadker, 1994). Many teachers and students believe these generalities exist, and middle and high school level standardized test scores support it. But the root of how these generalizations come about is a topic of intense debate. Are girls biologically predisposed to excel at language and relationships and boys to excel at math and spatial relations? Most educational researchers and scientists maintain that it is impossible to separate "nature" from "nuture" in determining the relative impact of the many forces that shape people's lives (Brazelton & Greenspan, 2000; Bryant & Check, 2000). Cultural expectations and constructions of gender are extremely powerful in shaping individuals' behavior and are so engrained that it is difficult to examine one's own culture. In the equity literature, it is assumed that differences in educational outcomes among large groups of people are primarily the result of cultural expectations and classroom experiences, not biology.

For example, Sadker and Sadker (1994) noted that teachers' beliefs that boys are smarter in mathematics and science begin in the earliest school years, at the very time when girls are getting better grades and equal scores on standardized tests. Many adults (teachers included) think that boys possess innate (i.e. biologically-based) mathematical and scientific abilities. They believe girls can achieve too, but they must work much harder (Sadker & Sadker, 1994). As a result of these gendered expectations, teachers send messages to students in line with their beliefs that can shape educational outcomes. Also, a marked reduction in the gender gap in secondary mathematics achievement over the past decade and longstanding equal performance in elementary school (AAUW, 1992; 1998; Dweck, 1980; National Center for Education Statistics, 1999) strongly supports the notion that if biological differences do exist, they need not determine educational achievement.

The literature that documents subtle and blatant teacher bias against girls is one piece of a puzzle that has negative implications for girls' confident participation in school. Decreased confidence is especially probable in subject areas such as science, math and technology in which many teachers assume that girls' have less talent than boys.

Student Bias

Beliefs about what boys are girls are supposed to do are also transmitted through peer relationships. The messages boys send to girls are both subtle and blatant, and, as with teachers, powerful in defining girls' "place" in areas such as science and math. As with teacher bias, student bias against girls is most pronounced in areas such as science, math and technology because of a cultural belief that boys should outperform girls in these areas. The following examples will illustrate this point.

McLaren and Gaskell (1995) interviewed high school girls in physics class about their experiences and found that girls identified more biased treatment by boys than by teachers.

> In our class there is one guy and he is really, really smart; he has a 90% average and over and he kind of looks at me as if I'm not supposed to be in that class. And he kind of thinks that he's smarter than me and that I'm wasting my time in that class. And then when I get a good mark on my test, I feel really good because I proved to him that I'm not stupid, that I can do it too (p. 145).

Another girl said there was no difference in the way boys and girls were treated except sometimes "you do something wrong and the guy would look at you and go, 'Air head.' . . . So a lot of times you do get called air head and stuff like that, but I'm used to it" (p. 145-146). She did not identify this as a problem since she was committed to pursuing science and wanted to remain friends with the boys in her class. Another girl felt more strongly.

> I don't like the guys telling me that I'm not as good as they are in whatever area it might be. It's like . . . a long time ago, women were, you know, staying home and doing the housework but now … maybe they say it as a joke but it really gets to me. I don't know why. Whatever we're doing, they're always making comments about how women are inferior and stuff like that (p. 147).

The frequency of the put-downs by the boys can lead to self-doubt.

> There's some guys, you know, smarter in our class and they automatically take women as a lower thing in life or whatever. And I think whether you

> mean to or not, that does get in the way and you start thinking, "Oh well, he's smart; he must know" (p. 148).

McLaren and Gaskell (1995) suggested that boys may feel freer to harass girls in science than in other classes because of larger cultural messages that science is a male domain. They argued that gender should be an official part of the science curriculum to affect change in these attitudes, instead of leaving students to deal with it informally.

Girls may also act as if they don't want to or can't do science because "acting girly" brings attention from boys. For example, Peggy Orenstein observed middle school girls shrieking when a boy dangled a spider in front of them that he had captured for extra credit in science class. They made a big deal about it and the boys did too. After the hoopla, a girl told Orenstein, "I'm not *really* afraid of that stuff, except snakes and blood. But guys like it if you act all helpless and girly, so you do" (1994, p. 22). Peggy reflected on these scenes she witnessed again and again and wrote,

> With each flight toward traditional femininity, I thought about who has permission, who has the right in our culture, to explore the natural world, to get dirty and muddy, to think spiders and worms and frogs are neat, to bring them in for extra credit in science. In fact, to be engaged in science at all (p. 22).

She also observed several other incidents that reflect how peer interactions shape expected gender roles in science class. In one lab group comprised of two girls and one boy, the girls watch the boy complete a Cartesian diver experiment, offering encouragement but no criticism. The girls squeal with delight when he gets it right and then he lets them each take one turn with the diver before recovering it and continuing to play by himself.

In another group, Roger stands behind the two girls in his group and watches for a moment before taunting, "You're doing it wrong," in a singsong voice. The girls huddle together, try to ignore him and continue to attempt the experiment.

> Roger watches them a moment longer, then grabs the bottle from them, pours the water into the beaker and walks away with the dropper. The girls do not protest. When he comes back a few minutes later, the girls have refilled the bottle, but, still uncertain about how to proceed, have decided to empty it again and start over.
>
> "Oh, smart," Roger says sarcastically. "*Real* smart." He grabs the bottle again. "*I'll* do it." He refills the bottle puts the dropper in, and completes the experiment while the girls watch in silence (p. 25).

In one final example, several girls are having trouble getting their Cartesian diver to work and ask a boy for help. A girl tells Orenstein, "I told him he could do it for us because he has man's hands." Another boy watching the scene exclaims, "Yes! A *man* had to do it!" when his friend completes the experiment. When a girl in the group asks the boy how he did it, he laughs and answers, "I have magic hands. *Man* hands." Orenstein writes that the girls laugh too – acting appropriately 'helpless and girly' – but they never learn how to do the experiment (p. 26).

These examples illustrate that boys and girls are very aware of the cultural expectations for males and females in science. Both boys and girls reinforce these stereotypes through the comments they make to each other, the types of activities they feel free to engage in, and the types of activities they view as gender-specific. As a result, girls learn that their full participation is not expected in science, in fact it is sometimes actively discouraged, so they are more likely to lose confidence and interest in the subject than boys.

Course material bias

Students continue to encounter a male-dominated world in their textbooks, classroom posters and course presentations (AAUW, 1998; Sadker & Sadker, 1994). The historical contributions of men make up the majority of history (in all subject areas) that students learn in school. They study male inventors, writers, poets, artists, leaders, and warriors much more than they study women who also filled these roles and other roles that are not as valued in our culture (Sadker & Sadker, 1994). Not only do textbooks and other materials ignore all but the most "notable" women (e.g. Joan of Arc, Marie Curie, Amelia Earhart, Harriet Tubman), they also do not discuss *why* women are omitted (Sadker & Sadker, 1994). Just as there is evidence of white men taking credit for the accomplishments of black men in US history, the same is true for women (Sadker & Sadker, 1994). Historical education ideally would examine how having the legal power to vote, own property, publish, attend college, etc. have framed the contributions of men and women to society, but they often do not.

Sadker and Sadker (1994) recount a story of a challenge they posed to a history class of high school seniors that highlights how course materials influence the development of students' knowledge of and attitudes toward the abilities of women.

> "You have five minutes. Your challenge is to name twenty famous U.S. women from the past or present – no sports figures, no entertainers, and only presidents' wives who are famous in their own right. Do you think you can do it?"
>
> The class stares back at us as if we have insulted their intelligence. As honor students in a competitive high school, several have already passed advanced placement history tests. "It's not as easy as it sounds," we warn.
>
> "Oh, c'mon. It's a cinch," a boy in the front mutters. …

> At first the students write quickly, but after a minute or two several are squirming in their seats and looking around at one another self-consciously. . . .
>
> "Time's up," we announce. "Please put your pencils down. How many of you have listed twenty women?" Not a single hand goes up. "Nineteen?" Still no hands. "Eighteen? Seventeen? Sixteen?" At this point a single Asian-American girl comes forward and at our request reads her list: "Eleanor Roosevelt, Harriet Tubman, Betsy Ross," she begins.
>
> "I've got them," several students call out. "I could only think of three, and she just named them," a girl admits. ...
>
> "Why do you think you had so much trouble naming women?" we ask after the girl has finished her list.
>
> "Women didn't do anything," a boy says.
>
> "Nothing?" we probe.
>
> "Cooking." "Cleaning." "Having babies." Boys call out from around the room. One male offers the following definitive statement: "From the dawn of human times to almost the present day women have been irrelevant in history. They have been on the sidelines. Except for the suffrage movement they haven't done anything. I don't mean to upset people, it just happens to be the truth." But the comment is upsetting. "What do you expect?" one girl retorts. "There was discrimination. Women lived in men's shadows" (p. 129).

The researchers have students examine the posters in the room and count the number of men and women represented in them. They find more than three hundred men but only eleven women. The students are surprised by the disparity. A girl asks, "But did women really do anything worthwhile? I mean, like Mark says, maybe we were irrelevant." They then display books about the lives of girls and women and mount posters of women in the room. A girl comes up to them and says, "I'm very glad to know this. I hardly know any famous women, and it makes me feel bad, as though I can't do anything. I like science, but this is the first time I've seen books about women scientists. Can I please borrow the book about Barbara McClintock? I want to learn more" (p. 129-130).

As this illustrates, students want to learn about interesting people, and learning about more women may help girls and boys expand their vision of life's possibilities. In fact, there are many women from history and today that merit inclusion in curricula (Sadker & Sadker, 1994) who are omitted due to precedence, oversight or discrimination.

Course material bias in male-dominated areas such as science is especially problematic for students' developing identities because it reinforces larger cultural stereotypes and girls' self-doubt that they can excel in 'male' domains. The same girl in McLaren and Gaskell's (1995) study who admitted self-doubt because of put-downs by boys in science class also attributed her lack of confidence to curricular materials. She continued,

> You start thinking, in all the textbooks and stuff all you see is guys. . . In the textbook you see, this guy invented this sort of thing, a lot in the math and sciences. That's all you really see. You start thinking, "Oh, maybe it's because females can't really do that," and I think, that sort of affects [girls], maybe not because they really particularly think about it, but I think that it may have something to do with it unconsciously or whatever. I just sort of get that impression (p. 148).

The 1998 literature review by the AAUW indicated that textbooks are somewhat more balanced than they were in 1992, but critics argue that the inclusion of more women into the materials is more about quantity than quality. Women have a greater visual presence in texts, but are often pictured in stereotypical roles, and the overall historical narrative presented to students has not changed since the research done by Sadker and Sadker.

<u>Parental Bias</u>

Parents' attitudes about their children's abilities can also have a powerful impact on the development of self-concept. While some parents actively resist gender-stereotyped expectations for their children, less critical parents may inadvertently contribute to larger cultural stereotypes. For example, many parents foster their sons' interest in traditionally masculine fields such as math, science, computers by buying mechanical toys for them and putting a computer in their room while assuming these items wouldn't interest their daughters. Early exposure to science-related toys and hobbies has been shown to positively correlate with later science achievement (Kahle & Meece, 1994). Some parents maintain different expectations for the types of courses their sons and daughters should pursue and achievement in those courses based on gender stereotypes.

Orenstein (1994) recounted a story about Lindsay, a girl in the advanced math track at a suburban middle school. Lindsay was experiencing anxiety attacks at school and home and doctors could find nothing wrong with her. It turned out that she was failing math and she was terrified of her parents' reaction. However, her parents were so relieved to find out what was wrong with her that they weren't angry at all. In a discussion with Lindsay's mother, Orenstein asked if the panic attacks could be seen as a warning that Lindsay was placing too much pressure on herself. Her mother instead thought that they were a result of her being placed in a class beyond her capabilities.

> We were surprised that Lindsay was placed in algebra at all. She has always gotten B's in math, so that's not her strong subject. . . . I think the panic was just from not knowing what was going to happen if she brought home an F. We didn't kill her, and I think she was surprised. But I said, "Now if there's any other class where you *should* be doing well and you get and F – *then* you'll be killed for sure" (p. 49).

Perhaps Lindsay's mother really was basing this attitude on her daughter's academic record and not gender stereotypes, but given a larger culture in which women are viewed as less capable in math (and science) than men, her parents did nothing to counteract gender stereotypes and gave Lindsay permission to opt out of advanced math coursework. It is in this way that parents may reinforce the culture of the classroom and contribute to girls' lack of confidence in areas considered male domains.

Development of Learning Orientations

As a result of cultural expectations and behavior in the classroom, girls are likelier than boys to have their abilities overlooked, particularly in science and math (AAUW, 1998). These oversights and the corresponding messages sent to girls about their abilities obviously threaten girls' confidence with which they begin school. There is a documented correlation between a girl's confidence in her abilities and her continuation in science and math (Furger, 1998). Although males drop out of these fields because they can't do the work, females drop out despite their abilities (Furger, 1998). Therefore, confidence is as critical to success as competence for girls, particularly in subject areas where they may feel unwelcome or a bit uncomfortable about their "place" there.

A psychological framework offered by Carol Dweck and Barbara Licht (1980) helps illuminate how views of science and math as masculine directly contribute to girls' lower levels of achievement in these areas than boys. Dweck and Licht suggest that the typical view of math (and science) as "masculine" and language as "feminine" has come about because boys and girls develop different learning orientations based on their different experiences in school, not because males and females have different inherent intellectual strengths. I will review their thesis that focuses on math and language and then relate it to student learning in science.

Dweck and Licht (1980) researched children's responses to failure and grouped students into two groups, helpless and mastery-oriented. Helpless children attributed failure to lack of ability and were quick to give up and avoid tasks that seemed too difficult. Mastery-oriented children attributed failure to lack of effort or concentration and persisted with confidence that they would eventually solve a problem they were working on. Mastery-oriented children accurately recalled their successes, thought they were performing as well as or better than others, and expected their success to continue. Helpless children underestimated their past successes and ability, thought others were performing better than them and predicted poor future performance.

Dweck and Licht (1980) looked at gender differences among these two learning orientations in their research and the work of others and found that girls exhibit a helpless learning orientation more often than boys. They offered an interesting perspective on the apparent mismatch between girls' achievement in the classroom and their confidence. As stated in the introduction, girls receive higher grades than boys all through school, and in elementary school girls are favored by teachers for their behavior, academic effort and overall maturity. As a result of these behavioral differences, boys receive far more criticism overall than girls. Boys and girls also receive different types of criticism. Boys are criticized more often for their nonintellectual performance (i.e., behavior, motivation, etc.) than for the intellectual aspects of their work. Girls rarely receive negative feedback for nonintellectual aspects of performance, so the majority of criticism they receive is aimed at intellectual features of their work. As a result, boys are more likely to attribute failure to lack of effort or discord with the teacher rather than to lack of ability. Meanwhile, girls receive praise from teachers for their motivation, effort and behavior, so it is implausible for them to attribute failure to teacher bias or lack of effort. Instead, they conclude that failure means they must lack intellectual ability. Failures are quite salient for girls who demonstrate a helpless orientation; they are more likely than mastery-oriented students to expect future poor performance and to avoid areas in which they think they lack ability.

Furthermore, Dweck and Licht analyze the presentation of math and language coursework and relate this to learning orientation differences. They characterize math as a subject area in which failures can be quite salient as answers are generally right or wrong. Language, on the other hand, is a subject in which deficiencies in one area (spelling, punctuation) can be compensated for by strong performance in another (creativity, presentation of ideas, grammar), so that one's overall grade is still acceptable.

Since girls are overly represented in the helpless learning orientation in which failures are perceived to reflect lack of ability, any failure in math may convince girls that they are inept and lead to psychological difficulty in mastering material which is challenging and avoidance of math coursework. The probability of failure or difficulty in math is greater than in language arts since a new unit in math may involve completely different concepts than previous one (algebra vs. geometry). Since math coursework gets more complicated as one progresses through school, failures may be more common at the secondary level. This may be one explanation for girls' decreasing achievement. Failure in math for students who experience a mastery-orientation (in which boys are over-represented) would not cause self-doubt as members of this orientation persist in the face of a challenge and do not internalize failure as a result of lack of ability.

In language, however, students with a helpless learning orientation are less likely to feel that they have failed overall because there are many areas in which they can excel even if they struggle with some aspect of the work. Teachers can soften the blow of poor performance with comments such as "You have wonderful handwriting and great ideas, but you need to work on your sentence structure." Boys may feel that the more subjective nature of language grading gives teachers an opportunity to reflect personal dislike of the boy in his grade. In this sense, boys may perceive math as a subject area in which there is less room for teacher bias to affect their grade; they either get the arithmetic right or wrong. This offers an explanation for girls' stronger performance in language arts and boys' stronger performance in math.

Their framework also makes sense of the fact that teachers report they are afraid to criticize girls performance because they take it too hard and they don't want to upset them (Sadker & Sadker, 1994). Myra and David Sadker argue that this is "killing with kindness" because girls end up receiving a poorer quality education than boys.

Since this article was written in 1980, the math education reform movement has tried to debunk the notion that there is only one right answer in advanced mathematics and has sought to incorporate more problem-solving throughout the curriculum. The reduction in the gender gap in mathematics achievement in light of Dweck and Licht's thesis is interesting. Perhaps the changes in math class have been successful in including a broader range of learning styles, and have made failures less salient for those who feel that difficulty suggests low intellectual ability.

Their thesis has implications for science as well. Boys continue to outperform girls on standard measures of achievement in secondary science (except biology) and girls opt out of advanced science coursework in greater numbers than boys. Science, like math, is often presented as factual, linear, numeric and objective. "Cookbook" science "experiments" are designed to lead students to one right answer and have dominated the curriculum. Scientists would point out that these exercises commonly referred to as "experiments" are not experiments at all, but only demonstrations or exercises in following a particular procedure. True experiments are far more creative, engaging and open-ended. Additionally, units or courses in science can vary so much that previous work may not seem relevant to new material (e.g., chemistry vs. physics). Thus, as in math, the probability for difficulty in understanding new concepts and doubting one's ability is greater than in language courses where concepts have more of a spiraling nature.

This and other research clarifies the connection between self-esteem and academic achievement, especially in math and science (AAUW, 1991; Orenstein, 1994; Sadker & Sadker, 1994). When girls lose confidence in their ability to learn math and science, they avoid these subjects. Their fewer experiences render them less capable in the long run. So there is a vicious cycle of confidence, participation, self-esteem and achievement that is, in part, responsible for the gender gap in math and science that emerges in adolescence.

Adolescence – A Cultural Initiation

All lives have ups and downs.
For most women, early adolescence is a big dip down (Pipher, 1994, p. 267).

A loss in academic confidence is one piece of a larger picture of diminishing confidence experienced by adolescent girls in our society. Research on developmental issues unique to the adolescent years has shed light on how challenging these years are for all children (Hurd, 2000; Scales, 1995). It is generally the middle school years, ages 11-14, in which students must grapple with changes in their bodies, increased social pressure to conform to peer culture, hormonal ups and downs, increased awareness of sexuality, and greater awareness of gender roles that apply to themselves. Both boys and girls struggle with these issues, but in general, girls emerge from the storm with their self-esteem less in tact than boys. This plunge in self-confidence unique to adolescence is one of the major forces that has implications for middle school girls' participation, interest and learning in school, especially in science.

Much research was done in the 1990s on girls' passage through adolescence that offers meaningful perspectives on ways in which our cultural expectations demean girls. Individual girls and those from different ethnic groups have many varied experiences and responses to the challenges of these years. For example, far more African-American girls retain their self-esteem during adolescence than white or Latina girls. They are almost twice as likely to say they are "happy with the way I am" than girls from other groups and say "they are pretty good at a lot of things" at nearly the rate of white boys (AAUW, 1991). Latina girls, on the other hand, suffer the worst self-esteem drop. The number of Latina girls who are "happy with the way I am" plunges between the ages of nine and fifteen by 38 percentage points, compared to a 33 percent drop for white girls and a 7 percent drop for black girls (AAUW, 1991; Orenstein 1994). Qualitative studies by Orenstein (1994), Pipher (1994), and Brown & Gilligan (1992) illuminate the complexities in girls' lives and indicate that some girls maintain a sense of self and direction better than others. These authors share the conclusion that many girls experience a loss of confidence through their interactions with others and in response to American culture; a loss that takes years to recover from, and, in some cases, only if one is aware of what has happened.

Loss of Voice

In Brown and Gilligan's (1992) decade-long study of girls in a private school, they describe an adolescent drop in confidence as a "loss of voice." Girls at ages 7 – 11 showed clear evidence of strength, courage and healthy resistance to "losing voice and relationship" (p. 4) in their interviews. Speaking honestly and freely about their opinions and feelings was an ordinary part of relationships. However, as the girls reached adolescence, ages 11-14, they experienced a marked change in their willingness to speak their opinions. Honesty in relationships began to be described as "selfish," "rude," or "mean" (p. 217). As a result, the girls kept their feelings to themselves, and spent more time trying to be what others wanted them to be in order to fit into the crowd. This process of "dissociating" from themselves led to increased confusion and marked increase in the number of times older girls used the phrase "I don't know" in interviews than when they were younger. Brown and Gilligan indicate that this loss of a strong sense of self is psychologically unhealthy and indicative of a developmental crisis in girls' lives.

Similarly, Pipher (1994), a clinical psychologist who specializes in the treatment of girls and women, argues that adolescent girls often abandon their "true selves" for "false selves" through the process of becoming focused on what others want them to be. Girls stop thinking, "Who am I? What do I want?" and start thinking, "What must I do to please others?" As a result, vibrant, confident girls become shy, doubting young women. Pipher suggests that because self-esteem is based on the acceptance of all thoughts and feelings as one's own, girls lose confidence as they "disown" themselves. They suffer enormous losses when they stop expressing certain thoughts and feelings. (p. 38). And girls know they are losing themselves. One girl said, "Everything good in me died in junior high" (p. 20).

Cultural messages

Pipher focuses on the ways in which our culture is responsible for this developmental crisis. Cultural messages, by their very nature, permeate society and are sent through the media, peers, parents and teachers. Even while some parents and teachers in particular try to counteract these messages, they are omnipresent and difficult to combat.

For example, a review of the mass media reveals the shallow expectations our society communicates to girls. Materialism, sexual activity, and beauty are honored and the opposite scorned or ignored. Beautiful models permeate magazines, television programs and movies. Today, the average model is taller and thinner than the average American woman. In 1951, Miss Sweden was 5 feet 7 inches tall and weighed 151 pounds. In 1983, Miss Sweden was 5 feet 9 inches tall and weighed 109 pounds (Pipher, 1994, p. 56). The new beauty standards are based upon women who either are genetic freaks of nature or have an eating disorder. Upon examination of several popular teen magazines, Pipher suggests they are a good example of the training in 'lookism' that girls receive.

> The models all looked six feet tall and anorexic. The emphasis was on makeup, fashion and weight. Girls were encouraged to spend money and to diet and to work out in order to develop the looks that would attract boys. Apparently attracting boys was the sole purpose of life, because the magazines had no articles on careers, hobbies, politics or academic pursuits. I couldn't find one that wasn't preaching the message "Don't worry about feeling good or being good, worry about looking good" (p. 40).

The media are often indicted as responsible for the rampant eating disorder problem among adolescent girls and young women. Most young women just can't measure up to our standards of beauty and are harming themselves trying to do so. On any given day in America, one half our teenage girls are dieting and one in five young women has an eating disorder (Pipher, 1994, p. 185). "Girls as skinny as chopsticks complain that their thighs are flabby or their stomachs puff out. They have been culturally conditioned to hate their bodies, which are after all themselves" (Pipher, 1994, p. 184). The importance of attractiveness and socializing often dominate girls' priorities. If they feel that they are not successful in these areas, girls' self-confidence may plummet and, in turn, exacerbate decreasing academic confidence.

Conflicting cultural messages about sexuality also undermine girls' sense of self. Nice girls are supposed to set limits and girls who do too much are branded "sluts." Boys are expected to "get as much as they can." Television programs, advertisements and movies, even those targeted at teenagers, present casual sex as commonplace, fun and sophisticated. These mixed messages leave adolescent girls unsure about how to handle their own sexual desires and physical attractions. Mary Pipher highlights this issue in her description of how Cassie's teenage world differs from her own.

> Cassie has read books on puberty and sexuality and watched films at school. She's seen explicit movies and listened to hours of explicit music. But Cassie still hasn't heard answers to the questions she's most interested in. She hasn't had much help sorting out when to have sex, how to say no or what a good sexual experience would entail. … The values she learned at home and at church are at odds with the values broadcast by the media. She's been raised to love and value herself in a society where an enormous pornography industry reduces women to body parts. She's been taught by movies and television that sophisticated people are sexually free and spontaneous, and at the same time she's been warned that casual sex can kill. … Cassie knows girls who had sex with boys they hardly knew. More touching and sexual harassment happens in the halls of her school today than did in the halls of mine. Girls are referred to as bitches, whores and sluts (p. 245).

The insecurity and confusion about proper behavior that results from these mixed messages add to girls' overall lack of confidence and comfort with expressing their feelings that crescendos during adolescence. Since sex, fashion and looks receive far greater attention in the media than goals, personality or academics, many adolescent girls buy into the notion that they are defined by these superficial qualities, rather than more personal and meaningful ones.

<u>Sexual harassment</u>

Mary Pipher (1994) contends that our culture is misogynistic, sexualized and promotes a view of girls as objects, not complex human beings. These messages give license to boys to harass girls, and they do so in far greater numbers than girls harass boys (Orenstein, 1994). Sexual harassment is a serious problem as true harassment, as opposed to flirting, is an assertion of dominance over another and leaves the victim feeling bad, rather than good about herself. The AAUW report, *Hostile Hallways,* reported that 70 percent of girls experience verbal harassment, 50 percent experience unwanted sexual touching and 25 percent report being cornered and molested at some point in their schools (AAUW, 1993). Sexual harassment is one more piece of a puzzle that documents the numerous forces than undermine girls' confidence in adolescence.

Comments from students help illustrate the reality of sexual harassment and how boys and girls perceive its seriousness. Girls recount boys' remarks in detail:

> They talk about boys who say, "Suck my fat Peter, you slut," who call them "skank" and "ho"[the rap version of whore]. They talk about boys who pinch their bottoms in the hallways or grab their breasts. They insist that it isn't just "bad" boys who badger them: it's boys with good grades, boys who are athletes, boys who are paragons of the school. And, they all agree, their fear of reprisal is much too acute to allow them to confront their harassers (Orenstein, 1994, p. 120).

One boy who was punished for grabbing a girl's breasts told Orenstein,

> I don't remember doing it, but maybe I did. All the guys do that stuff, it's no big deal. The girls don't mind. I mean, they don't do anything about it. I'd beat the crap out of someone if they touched me like that. But girls are different, they don't really do anything, so I guess it's okay to do (p. 129).

Since sexual harassment is more about power and dominance than sexuality, it highlights for adolescent girls and young women that boys have more power than they do. Girls fear standing up for themselves because they believe they won't get support from those with power. And they are often correct. Even in schools where teachers, counselors or administrators have tried to enforce sexual harassment laws, they have run up against a lack of understanding of and commitment to facing the problem (Orenstein, 1994).

<u>The Perfect Girl</u>

In early adolescence girls experience rigorous training in femininity. At this time girls are expected to "sacrifice the parts of themselves that our culture considers masculine on the altar of social acceptability and to shrink their souls down to a petite size. The rules remain the same as they were in the fifties: be attractive, be unselfish and of service, make relationships work and be competent without complaint" (Pipher, 1994, p. 39).

Brown and Gilligan (1992) refer to this as the standard of 'the perfect girl.' They write that in white middle class America, she is...

> ...the girl who has no bad thoughts or feelings, the kind of person everyone wants to be with, the girl who, in her perfection, is worthy of praise and attention, worth of inclusion and love. ... Other girls describe her as the girl who draws perfectly... the one who is "so good in math"... the girl who speaks quietly, calmly, who is always nice and friendly, never mean or bossy (1992, p. 58-59).

The girls in their study talk about this ideal as something they are supposed to be yet cannot be. Social rules dictate that this is how they should *act* if they want to be liked and accepted. Orenstein suggests the "perfect girl" acts as an imaginary companion and a constant reproach. She reminds young women to silence themselves rather than speak their true feelings (p. 37), for if they do, they will be scorned by the group. "When you are really mad at somebody and you want to say something really bad, but you can't, you just can't" (Brown and Gilligan, 1992, p. 59). At age eleven, this girl is terrified of what might happen if she says what she feels, when at age eight, she told the interviewers that if a friend upset her she would say, "This is making me feel bad, I'm going home" (Brown and Gilligan, 1992, p. 60). It is not only peers who encourage girls to be nice rather than honest. "The worst punishment is to be called a bitch. That will shut anyone up. Girls are supposed to smile. If I'm having a bad day, teachers and kids tell me to smile. I've never heard them say that to a guy" (Pipher, 1994, p. 39).

Many white girls learn this lesson well, and one problem is that the "perfect girl" is too nice to achieve in areas considered "masculine." This sets up a conflict for girls who are overtly encouraged to achieve their potential in all areas, but feel they must choose between being 'cute' and 'competent.'

> "My parents would be proud if I were a surgeon,' says Suzy, who is an only child. "But it's too gross – whenever I think about it I think about the shower scene in *Psycho* . ... I think I may be a lawyer."
>
> Lindsay snorts at this notion, which she seems to view as ludicrous. "I'm trying to imagine this sweet girl questioning someone on the witness stand," Lindsay says, still laughing, "She'd be in a cold sweat."
>
> "It's true," Suzy says sheepishly. "I'm too cute to be a lawyer."
>
> "Yeah," says Lindsay. "You'd be like: 'Did you kill him? No? Oh, okay, sorry.'" She ducks her head shyly, still playing Suzy-the-lawyer, and pretends to turn and slink away.
>
> "It might be interesting though," Suzy says, still trying to be taken seriously.
>
> "*Interesting?*" Lindsay exclaims. "Well, that's one way of putting it. You'd meet some characters, all right."
>
> Suzy capitulates and joins the game. "Yeah, all the guys you'd meet would be murderers. Can you imagine?"...
>
> As used by Lindsay and Suzy, "sweet" and "cute" are interchangeable with "deferential," "polite," or "passive." They are code words for that time-honored notion of the good girl: the girl who is nice before she is anything else- before she is vigorous, bright, [or] honest. As the girls talk, Suzy tries to put forth an alternative vision of herself, imagining all the opportunity her sharp intellect could provide, but in the end she betrays both her intelligence and her ability to agree with Lindsay: she is too cute to be competent. This in spite of the fact that law is now an acceptable field for bright women to enter. This in spite of the fact the Suzy's own aunt is a judge (Orenstein, 1994, pp. 34-35).

Unfortunately, "by adolescence, girls have learned to get along, while boys have learned to get ahead" (Bower, in Orenstein, 1994, p. 287).

Implications for Science Education

It is well documented that girls' passage into adolescence is "marked by a loss of confidence in herself and her abilities, especially in math and science. It is marked by a scathingly critical attitude toward her body and a blossoming sense of personal inadequacy" (Orenstein, 1994, p. xvi). This loss in confidence has direct implications for girls' academic success, especially in science. As stated before, researchers have long understood that a loss of confidence usually *precedes* a drop in achievement (Furger, 2000; Orenstein, 1994; Sadker & Sadker, 1994). The middle school level is when the gender gap in science achievement becomes statistically significant, and the gap grows through high school and beyond. Perhaps this is because in adolescence, many girls begin to accept the notion that being feminine (i.e. 'the perfect girl') is incompatible with success in "masculine" subjects such as science.

The lessons girls learn in adolescence include that they are to be more cute and nice than outspoken and competent if they want to be accepted by their peers. At times in the science classroom, they get positive attention for acting "girly" and see their efforts belittled or ignored. They begin to understand that they lack power in relation to boys, and that deference is part of what it means to be feminine and attractive. Many buy into the notion that appearances (physical and emotional) are their most important assets. They realize that femininity is equated with passiveness and masculinity with aggressiveness. All of these experiences and realizations chip away at girls' confidence and freedom to be both passive and aggressive, cute and competent. This helps explain Orenstein's comment that "Few of the girls I spoke with had ever been told that girls 'can't' do what boys can – most were overtly encouraged to fulfill their potential. Yet all, on some level, had learned this lesson anyway" (p. xxviii).

The challenges girls face during adolescence are so powerful, multifaceted and detrimental that the middle school student population is important and interesting to study. Adolescent girls, in general, face challenges that have the potential to demolish any confidence with which they begin middle school. When these challenges are combined with an increasing awareness of femininity and an acceptance of science as masculine, it is no wonder that there is a drop in girls' interest and achievement in science at this time. The challenge in science education reform is to determine what can be done to combat these forces in girls' lives to allow them greater opportunities for confident participation in science.

The Culture of Science

Another important aspect to consider when exploring girls' interest and achievement in science is the culture of science. As stated in the introduction, this is a main component of the conceptual framework. "Science" is a method for investigating the natural world. The processes of science are often confused with the products of science. Science provides a particular lens for exploring and understanding the natural world. The culture of science includes, in part, these operating paradigms (i.e., methods used when employing a scientific worldview) and standards for membership in the scientific community. The research reviewed in this section shows that the dominant culture of science reflects ways of knowing that are associated with masculinity in our society and that feminine ways of knowing are constructed in opposition. Males dominate professional scientific communities and women are at times actively excluded from prestigious participation in those communities. Feminist critiques of science illuminate how these issues, as well as how conflicting worldviews between feminine and masculine ways of knowing the world, interact to perpetuate science as a male domain. The research has direct implications for girls' interest, participation and learning in the science classroom.

Women's Experience in Science

> It may be difficult for those removed from the mores of the scientific community to understand the enormous reticence with which anyone, especially a woman, would make public his or her personal impressions and experiences, particularly if they reflect negatively on the community. To do so is not only considered unprofessional, it jeopardizes one's professional image of disinterest and objectivity. Women, who must work so hard to establish that image, are not likely to take such risks. Furthermore, our membership in this community has inculcated in us the strict habit of minimizing any differences due to our sex (Keller, 1977, p. 90).

Women who manage to retain an interest in science past the middle and high school years have not made it past the battle. Studies indicate that discrimination often continues throughout higher education and, if women persist and begin a career in science, perhaps throughout their professional lives. As in the classroom, much of the discrimination is subtle, some of it overt, and all of it creates a climate that is hostile toward women. These statements make it seem a wonder that there are any women in science. Some women have more amicable experiences in sub-disciplines more open to women, some are willing to deny parts of themselves in order to fulfill their passion for science, others are encouraged by significant others to persist despite the difficulties. However, many women decide they are not willing to persist under hostile circumstances or that the limits they face because they are women are unacceptable to them.

In 1992 and 1993, *Science* magazine featured women in science in special sections devoted to topics surrounding women's participation and marginalization within the field. They claimed that "the science pipeline is leaking women"; the vast majority of women who begin careers in science never make it to top positions and drop out of the field in far greater numbers than men. One of the major obstacles women face is the expectation that they won't be as successful as men (Women in Science, 1992). The 1993 section entitled "Gender and the Culture of Science" focused on the ways in which the science establishment, comprised predominately of men, continues to reject women scientists.

Accounts of women's experiences in science at the higher education level and in careers provide story after story of discrimination by male peers and superiors which pushes women out of the field (Gornick, 1983; Keller, 1977; Sands, 1993).

Some examples include:

> A sixty-eight-year-old physiologist active all her life in university research said, "I worked for years among men who never walked into my office to talk to me, who nodded to me in the hall as they nodded to the maintenance men or the cleaning women, never invited me to their conferences or their seminars or their research programs. I was the invisible woman in science" (Gornick, 1983, pp. 73-74).

> A twenty-two-year old woman who graduated from Harvard with a BS in psychology had entered the university as a chemistry major (she had been an A student in chemistry in high school), but dropped out at the end of the first year. "Freshman chem is taught at Harvard by a famous chemist, a man in his sixties who would put an equation on the board and in a room of five hundred people turn and say, 'Get that, girls?' The first time I heard him say this I laughed. The second time I became angry. The third time I was scared. Something began grinding at my insides every time I walked into that lecture hall. I started thinking, *Do* you get it? *Can* you get it? And then I thought, You *don't* get it. You *can't* get it. I couldn't go on with it. The percentage of boys dropping out of science is high, but believe me, it's a thousand times higher for girls, and I know it's for the same reason I dropped out" (Gornick, 1983, p. 74).

Evelyn Fox Keller (1977), a leading feminist thinker in science, recounted her horrendous experience as a physics graduate student at Harvard which ultimately led to her dropping out. Albeit in the 1950s, her experiences frame the history of women in science, which by many accounts (Sadker & Sadker, 1994; Sands, 1993; Traweek, 1988) have not improved much since then, especially in physics.

> When I turned in particularly good work, it was suspected, indeed sometimes assumed, that I had plagiarized it. On one such occasion, I had written a paper the thesis of which had provoked much argument and contention in the department. This I learned, by chance, several weeks after the debate was well underway. In an effort to resolve the paradox created by my results, I went to see the professor for whom I had written the paper. After an interesting discussion, which incidentally resolved the difficulty, I was asked, innocently and kindly, from what article(s) I had copied my argument (Keller, 1977, pp. 86-87.)

The fact that many women in science are viewed as an anomaly is a serious deterrent. Their peers make them feel as if they are strange; not fully female (Sands, 1993). Their professors or superiors often question their competency or take credit for their ideas (Gornick, 1983; Keller, 1977; Sadker & Sadker, 1994). They see men who they outperformed offered more lucrative job opportunities (Gornick, 1983). Women are often funneled into second-class and dead-end roles such as in technical departments or as research associates where they carry out the science conceptualized by others, not using their intellect and creativity in ways that leads to advancement and power within the field (Gornick, 1983; Traweek, 1988).

Feminist critics examine the roots of this discrimination, looking, in part, to the history, practice and nature of science. A common thread in feminist critiques of science is that science is promoted as a masculine endeavor by scientists and science educators, one in which only boys and men can be highly successful.

Science as a Masculine Endeavor

> [As a graduate student in physics at Harvard] I was, clearly, a serious threat to my fellow students' conception of physics as not only a male stronghold but a male *retreat,* and so I was least likely to be sought out as a colleague (Keller, 1977, p. 85).

Feminist critics contend that the masculinity of science alienates many women (and others who value "feminine" characteristics over "masculine" ones) from being legitimate participants in the scientific culture. Kelly (1985) indicates several ways in which science is promoted as masculine:

1. *Numbers*: more males take advanced science courses, teach precollege and college science, and are recognized as scientists (national academies, Nobel Laureates, fellowships and research grants, etc.).

2. *Packaging:* science is presented as a masculine endeavor through gender biased curricular materials and instructional techniques, as well as applications and examples that reflect male interests and strengths.
3. *Practice*: classroom behaviors and interactions including teacher expectations, sex role stereotyping and student-student interactions that reinforce science as a male domain.

Elements of each of these categories have also been documented in the research on classroom culture discussed previously.

Furthermore, traditional views of the nature of science and the scientific method maintain that science is an objective, rational, individualistic, unemotional, reductionist and value-free enterprise (Brickhouse, 1994; Keller, 1985). These characteristics distinguish science from many other disciplines and promote its high status as a paradigm for understanding the natural world. These qualities are commonly associated with masculinity while qualities such as personal, emotional, intuitive, holistic, harmonious, and caring are associated with femininity (Carter, 1990; Keller, 1985). In our society, male and female characteristics are constructed dichotomously -- what one has, the other balances out by being the opposite (Nicholson, 1993, p. 10; Schiebinger, 1989, p. 234).

female	vs.	male
passive	vs.	active
weak	vs.	strong
emotional	vs.	rational
soft	vs.	hard
dependent	vs.	independent
cooperative	vs.	competitive
subjective	vs.	objective
indecisive	vs.	decisive

warm	vs.	cold
timid	vs.	aggressive
compliant	vs.	dominant
holistic	vs.	reductionistic

The historically pervasive association between masculine and objective, and even more specifically, masculine and scientific, is part of society's common knowledge, yet it is important to examine (Keller, 1985). Science is presented as having no room for subjectivity (and therefore femininity) since the goal of science is to attempt to understand an objective 'truth' about the natural world.

This traditional view of the nature of science still predominates in schools even while philosophers (Kuhn, 1970; Longino, 1990) and sociologists (Traweek, 1988; Collins and Pinch, 1993) have challenged it. These authors offer a more contemporary view of science in which science reflects the culture of the society in which it is practiced. They provide evidence and argument for viewing scientific practices as embedded in a cultural context; that science is influenced by the rules of the scientific community that proscribes theoretical and methodological boundaries. Additionally, they demonstrate how scientists' questions, interpretations and presentation of data are influenced by their own world view and subjectivities, thereby calling into question the value-free nature of scientific knowledge.

However, the public conception of science generally supports the former view -- science as an objective method to learn the truth about nature. The vast majority of students and teachers maintain this view (Lederman, 1992) and it continues to be the operating standard for many scientists (Collins & Pinch, 1993; Traweek, 1988). So, still today success in science often requires the abandonment of characteristics that our culture labels ‘feminine’ (Brickhouse, 1994; Women in Science, 1992).

The Sex/Gender Distinction

This discussion of science as masculine begs the question – are science/objectivity/reason/etc. really masculine (i.e. embedded in the biology of males)? If so, it is perfectly reasonable to accept that women are underrepresented in the field and lag behind in academic achievement. But, evidence points to the contrary (Bleier, 1991; Gailey, 1987; Haraway 1989; Keller, 1989; Longino 1990; Lowe & Hubbard, 1979; Star, 1979.) Gender is not sex. Feminist scholars find it important to separate the terms sex and gender in order to untangle our assumptions about “gendered” behavior. “Sex” indicates the classification of a person with regard to his or her anatomical status, while the classification of “gender” lies in social relations (Haslanger, 1993). While sex is (usually) a given, gender is not. According to Harding (1991), there is no ‘gender’ -- but only women, men and gender constructed through particular historical struggles over which races, classes, sexualities, cultures, religious groups, and so forth, will have access to resources and power (p. 151). In other words, one’s gender is identified based on one’s sex, but the meanings and expectations that are associated with that gender are created by society. As a result, gendered behaviors are not given, as they are intricately related to societal expectations and norms (Haslanger, 1993).

So, by many accounts, both science and gender are socially constructed. While this suggests that our associations between science and masculinity could radically change, this is unlikely to happen. Scientists who are drawn to the profession for its objective, rational, and linear qualities have a vested interest in keeping it this way, for science derives much of its status from these qualities. However, greater awareness of the nature of science presented by contemporary scholars -- that in reality, science is more of a collaborative effort than an individualistic one and that science is not so inherently masculine -- may break down some of these enduring perceptions of science.

Implications of Science as Masculine for Adolescent Girls

Children as early as kindergarten have identified science as for boys (Kahle, 1996), mostly through an awareness of gender-specific toys. Children's view of science as a male domain in the later years has been documented by having students draw a picture of a scientist. Students most often draw a white male, dressed in a laboratory coat, wearing glasses, who sometimes has an unruly appearance and looks a bit crazy (Kahle, 1989; 1994). This image of the professional scientist is perpetuated in the media as well as in many children's television programs about science. These media influences, images in textbooks, gender-specific toys, and the fact that most middle and high school science teachers are men, carry the message that science is "linked to the process of becoming masculine for boys but not to the process of becoming feminine for girls" (Sjoberg & Imsen, 1988).

The intersection of girls' burgeoning awareness of gender roles and the presentation of science as 'masculine' at the middle school level offers an explanation for why girls' interest and achievement in science drops more dramatically than boys at this time. The research already discussed on adolescent girls' induction into femininity illustrates how girls begin to enact more of these stereotyped characteristics than in their earlier years. Girls value their feminine characteristics, as they should. Therefore, many girls and young women become disinterested in a discipline so highly masculinized that they feel they must give up valuable parts of themselves to participate fully and legitimately.

Women's Ways of Knowing

Works by Carol Gilligan (1982) and Belenky, Clinchy, Goldberger and Tarule (1986) offer additional perspectives on how the dominant culture of science can discourage women's and girls' interest, participation and achievement. Gilligan (1982) and Belenky et al (1986) identify women's ways of knowing the world that are in contrast to men's. Their studies are predicated on the notion that male and female ways of knowing are not so much biologically determined as they are socially constructed. They maintain that while some members of each gender adopt ways of knowing that are most closely aligned with the other gender, their constructs apply to a majority of members of each gender. Their studies arose out of a response to the fact that some male psychologists had created models of normal development for all people using white boys and men as subjects. When applied to women, these models indicated that women's development was inferior to men's.

For example, in Kohlberg's (1981) study of moral development, women rarely expressed perspectives that were indicative of the highest stages of moral development in which relationships are subordinated to rules and rules to principles of justice (Gilligan, 1982). Instead of viewing the world through a set of objective rules about justice, Gilligan (1982) found that women were more likely to view decisions about the world through examining the complexity of relationships.

Gilligan described women as operating under an “ethic of care” rather than by the “logic of justice” (1982, p. 30). She concludes that while men observe the world from a vantage point of separation, women view it through a lens of human connection. She argues that instead of constructing women’s world views as inferior to men’s, models of women’s development need to “delineate *in women’s own terms* the experiences of their lives”(p. 173, emphasis hers).

Similarly, Belenky, Clinchy, Goldberger and Tarule (1986) identify four “ways of knowing” that they use to describe women’s experiences and perspectives. All but one of their “ways of knowing” categories includes a focus on emotion and care, to varying degrees of complexity and self-awareness. Like Gilligan, they offer the categories as a model that differs from Kohlberg’s study on men. In part of their study, they argue that the dominant paradigm of science (described in the Science as a Masculine Endeavor section) is discordant with most women’s paradigms that center around human connection, complexity and care. They recount some female participants’ experiences and attitudes toward science in ways that illuminate how some women feel alienated from science.

In one woman’s college class experience, she recounts the male science professor walking in on the first day and setting down a jar full of beans. After asking the students to guess how many beans were in the jar and they were all wrong, he announced, “‘You have just learned an important lesson about science. Never trust the evidence of your own senses’” (Belenky et al., 1986, p. 191). That afternoon, the woman dropped the course.

Another woman said, "What's missing in science is a whole sort of human element. It doesn't seem to be infused with any morality. It doesn't even seem to be a world about people anymore" (Belenky et al., 1986, p. 71).

One other woman recognized that science was more complex than is usually portrayed. She said about science, "You realize that you're dealing with a model. Our models are always simpler than the real world. The real world is more complex than anything we can create. When you try to describe things, you're leaving the truth because you're oversimplifying" (Belenky et al., 1986, p. 138).

Since science topics such as physics and chemistry particularly, are presented as isolated, discrete, and devoid of human context, many women become alienated from this way of knowing. The processes and perceived goals of these science topics are in opposition to what they find important in the world. Women may consequently find certain science topics and methodologies personally irrelevant.

Women's Ways of Knowing in Girls

Studies of girls' science interests at the K-12 level have also concluded that girls are interested in topics that center around care and connection. Roychoudhury et al. (1995) acknowledge that science is often portrayed as detached from the human element and that this turns off women who need to feel a connection with the subject matter they are studying. They cite studies that indicate that girls especially enjoy and appreciate courses that connect science to real-life phenomena. For women and girls, "it is important that there is a connection between themselves, the subject matter they are studying and the human race" (p. 110).

Similarly, Shroyer et al. (1995) found that there is a large percentage difference between male and female interests in science topics. Girls are "more interested than boys in information about AIDS, how traits are inherited (genetics), and understanding peoples' feeling or emotions" (p. 99). Girls are much more interested in socially relevant topics than detached ones (Shroyer et al., 1995; Sjoberg and Imsen, 1988;).

In Sjoberg and Imsen's (1988) study, 14-year-olds were asked to respond to the question, "Scientists make new things or try to understand what happens in nature and with people. If *you* could decide, what would you ask scientists to do?" The results indicated that girls' top research priorities were in the areas of health and anti-nuclear weapons while boys' top priorities were in technology and astronomy (p. 230-231).

Similarly, Kahle and Rennie (1993) found that girls scored significantly higher than boys on an interest inventory in their desire to study:

- how to grow your own vegetable or flower garden
- about moths, butterflies and caterpillars
- how compost helps plants to grow better
- how germs make you sick
- about mushrooms and toadstools
- how to look after mice or goldfish as pets
- how to do experiments with seeds.

Boys scored significantly higher than girls in their desire to study:

- how iron ore is made into steel
- about wheels and motors
- how to make working models from Lego or other kits
- how electricity makes the television work
- ways to make a flashbulb light up
- things to see if electricity passes through them (p. 324, 326).

These studies indicate that girls are more oriented toward biology while boys are more oriented toward physics. Biology is embedded in the connectedness of living things and girls can see the relationship between biology and themselves. This is not the case with the way physics is presented today. These studies support and explain findings documented in the AAUW (1992, 1998) reports that high school and college females take more advanced level biology courses while males take more advanced chemistry and physics courses.

Not only do girls prefer different science *topics* than boys, but they also may prefer different scientific *procedures* than boys. Franks and Miller (1995) wrote that girls would rather "spend longer in the hypothesis-generating phase" of the scientific method, "getting to know the material they are working with and bringing in ideas from analogies in their everyday life" (p. 29). Boys prefer to decide ahead of time how they will conduct an experiment as indicative of the hypothesis stage of the scientific method. This is yet another way in which girls and women can become alienated from the scientific enterprise. If their methods of performing science do not fit the proper scientific mold, then they are not doing it right. If their science interests have lower status than the interests of males, which is true of biology compared with physics, then they will look elsewhere for more welcoming and fulfilling careers.

Finally, Fensham (1988) reviewed the science content prevalent in school curricula since the 1960's. He created a list of the characteristics of this content in terms of how it is taught and conceptualized in schools. This list is especially appropriate since it directly relates to the prior discussion of why girls become alienated from science.

> (a) It involves the rote recall of a number of facts, concepts and algorithms that are *not obviously socially useful.*
> (b) It involves so little familiarity with many of these concepts that their *scientific usefulness is not experienced.*
> (c) It involves concepts that have been defined at high levels of generality among scientists without their *levels of abstraction* being adequately acknowledged in the school context so that their *limitations in real situations are not indicated.*
> (d) It involves an essentially abstract system of scientific knowledge, using examples of real objects and events to illustrate this system, *rather than* using scientific knowledge *to elucidate life experiences* and social application of science.
> (e) It *reduces the role of practical activity* in science education to the enhancement of conceptual learning *rather than* being a source for learning essential skills and gaining confidence in *applying scientific knowledge to solve real societal problems.*
> (f) It gives a high priority (even in biology) to *quantitative aspects at the expense of understanding of the concepts involved* (p. 11, emphasis his).

These characteristics of school science curricula are at odds with the values embedded in many women's ways of knowing.

Women's Ways of Knowing and Science Education Reform. Reforming science education in ways that reflect women's ways of knowing may benefit girls and boys alike. For example, Paul DeHart Hurd, a prominent author in the science education community, offers ideas for reform that reflect a departure from the traditional science model (2000). He argues that organizing all middle school curricula around students' interests will increase the motivation, participation, and achievement of both boys and girls at this developmental level. He suggests that adolescents are consumed with themselves and their social world, and that curricular reform should use this as an organizing principle. He suggests that science curricula should be interdisciplinary, social and maintain a science/technology/society focus. The S/T/S approach has always been associated with making science personally relevant. Such reform may benefit girls as well as a number of boys, and in turn, help achieve the national standard movement's goal to make science accessible to "all" students.

Gender and The Culture of Computing

The final section of this literature framework examines the culture of computing and how gender issues intersect with the use of computer technology in schools and society at large. The computing culture shares many similarities with the culture of science. Research indicates that computer technology is also viewed as a masculine domain and that girls experience biased treatment by teachers, peers, parents and course materials that contributes to their lack of interest in the field when compared with boys. When computer technology is used in the science classroom, as is becoming more commonplace, the combination of the science and computing cultures may compound these notions of masculinity and further alienate girls and others already disengaged from science. However, other research reviewed in this section presents an Internet culture that is markedly different from the larger computer culture. This Internet culture is described as grounded in human relationships and reflects ways of knowing that have been identified as feminine in the previous sections. While some research debates this, the notion that the Internet culture has greater appeal to girls than the general computing culture is an interesting and timely topic for study. When the Internet is used for communication and collaboration, it may serve as one entry point for girls into the computer culture, and if it is used in science, it may likewise promote girls' interest, participation and learning with the science curriculum. As stated in the introduction, the purpose of this dissertation study is to examine this very issue.

Gender and Computer Use

As stated in Chapter 1, computer technology of varying quality has become commonplace in most schools and understandings about its strengths and limitations in supporting educational outcomes are still being explored (Feldman et al, 2000; Windschitl, 1998). However, much research has been conducted on students' responses to the use of computer technology in the classroom and evidence suggests that most students, both boys and girls, have positive attitudes toward computers (Huber & Schofield, 1998; Mistler-Jackson & Songer, 2000; Schofield, 1995).

In particular, research has shown that students enjoy the change from typical classroom instruction that using computers bring, and that so far there has not been a novelty effect in which interest has dissipated over time (Schofield, 1995). Computer lab environments are typically more social and offer students more opportunities for personal control than the regular classroom environment, contributing to increased motivation (Schofield, 1995). Collaborative Internet projects like Journey North offer unique opportunities that have been shown to affect student interest positively. These include

- communication with other students and in some cases, science professionals (Lenk, 1992; Software Publishers Association, 1995; Songer, 1996, 1998; Wallace, Kupperman, Krajcik & Soloway, 2000),
- access to and the use of real-time information (Lenk, 1992; Songer, 1996, 1998),
- collaboration with others that creates a feeling of authenticity (Fishman & D'Amico, 1994; Lenk, 1992; Means & Olson, 1994).

Furthermore, research has shown that some students who don't normally excel especially enjoy computer use, and therefore take on leadership roles and accomplish tasks that they otherwise might not (AAUW, 2000). The fact that computer use allows for variable paces is one possible explanation for this benefit to students who are often left behind (AAUW, 2000).

However, research has also shown that girls, as a group, have slightly less positive attitudes towards computers than boys do (Huber & Schofield, 1998; Schofield, 1995). Many girls express the attitude that they can use computers proficiently but are not interested in pursuing computer science in school or for a career (AAUW, 2000). They describe the computer culture as materialistic, non-social ("sitting in cubicle all day"), and even stupid (AAUW, 2000; Schofield, 1995). Girls tend to view the computer as a utilitarian tool, while boys tend to view it as a toy or even an extension of themselves (Schofield, 1995; Turkle, 1984; 1995). Boys' more intimate relationship with the machine can lead them to spend more time tinkering with it, learning the intricacies of its operation, and becoming more comfortable with troubleshooting problems than girls or others who are not as interested. Sofia (1998) suggests that girls' cooler relationship to computers has been constructed as technophobic in our society by those in the computer culture (i.e. mostly men) who view technophilia as the norm. She contends that this is a mischaracterization and, in fact, girls exhibit a balanced view toward computer technology.

One of the most striking gender differences in the use of computer technology is found in the playing of computer games. Boys play computer games overwhelmingly more than girls (AAUW, 2000; Furger, 1998). This is most directly related to the fact that computer games are created by men for boys and men, and are actively marketed to a male audience (AAUW, 2000; Furger, 1998; Sanders, 1995). Most games revolve around themes that include violence, war, domination, and time pressure (AAUW, 2000; Sanders, 1995; Schofield, 1995). These themes traditionally fall under male interests in our society, and girls repeatedly express their distaste with these games (AAUW, 2000; Furger, 1998; Schofield, 1995). When asked what kinds of games they would like to play, girls have suggested themes that involve problem-solving, relationships, multiple-levels that require skill and strategy (not just shooting), social interaction, and engaging, customizable characters (AAUW, 2000; Riel, 2000). There are very few software games designed with girls in mind, and one of the best sellers has been the Barbie Fashion Designer software. Since the Barbie mystique tends to perpetuate the shallow image of girls that has been shown to contribute to girls' difficulty in adolescence, this is surely not the best the industry can do. Other programs are available and more are underway, but the choices are still very limited. Games provide an important entryway into the world of computing, so many girls are left behind at this juncture (Schofield, 1995; Upitis, 1998).

Studies of computer use at home also indicate disparities. Boys are far more likely than girls to have a home computer, and parents of sons are more likely to put a computer in their son's room and send him to computer camp than are parents of daughters (AAUW, 2000; Schofield, 1995). Girls often refer to the computer in their home as "my father's computer" or "my brother's computer" and indicate that they have to wait to use it until their brother is done with his (more important) 'stuff' before she can get a turn (Furger, 1998, p. 16).

Gender differences in computer use at school are remarkably similar to gender differences noted in science classes. Boys tend to do the work while girls watch when in mixed-sex groups, or girls perform the secretarial tasks while the boys make project decisions (AAUW, 2000; Huber & Schofield, 1998; Sanders, 1995). Girls in advanced high school computer science classes are few and far between and are often subject to more sexual harassment and isolation in these classes than in others (Schofield, 1995). The higher ratio of boys to girls in these courses has been offered as an explanation for this occurrence. In one case study, the only girl who managed to interact respectfully with the boys in an advanced computer science class publicly denigrated her own abilities and fit accepted feminine images (she was attractive, nice, and a cheerleader) (Schofield, 1995).

Also like many science classes, computer science courses are taught by men more often than by women, class activities and examples often reflect "male" interests more than gender-neutral ones, and course materials tend to stereotype men as designers of hardware and software and women only as users (AAUW, 2000; Sanders, 1995; Schofield, 1995). Boys are more likely than girls to use the computer lab during their free time (Schofield, 1995) and boys, even more strongly than girls, believe that computers are a male domain (Huber & Schofield, 1998). Teachers tend to give more assistance to boys than girls in computer classes and often believe that boys have greater interest and ability in computer use than do girls (AAUW, 2000; Huber & Schofield, 1998). While research results have varied regarding whether girls experience anxiety with computer use, Huber and Schofield (1998) found that girls' anxieties were not about programming, but about possible interpersonal difficulties or criticism they might receive for being too good or too interested in computer use. A high school girl enrolled in technology-related classes said that "A lot of the time, girls steer clear of technology classes because they are intimidated by the majority of males in the classes" (p. 18, Gehring, 2001). The AAUW (2000) reports that girls are not anxious about computer use at all, instead many have an "I can, but I don't want to" attitude.

The Computer Culture

In seeking to explain the gender differences in computing at school and at home, researchers have by and large focused on the masculinity of the computer culture in our society (AAUW, 2000; Sanders, 1995; Schofield, 1995; Sofia, 1998; Turkle, 1995). They note that it is the masculinity of the enterprise, not anything inherently mismatched between femininity and computing, that is responsible for the inequities. Schofield (1995) sums up this position quite well.

> Social arrangements and educational practices that isolate girls who want to use computers, that emphasize the link in our society between computing and masculinity, and that do not effectively compensate for the likely initial disparity in prior experience between male and female students tend to reinforce preexisting differences in interest and expertise by discouraging many girls from seeking out opportunities to use computers. Furthermore, although these factors do not actually create a *negative* attitude toward computing on the part of most girls, they are conducive to girls developing somewhat *less positive* attitudes toward computing than boys (p 163, emphasis hers).

The computer culture is traditionally considered masculine for a variety of reasons, many of which are portrayed in the "computer geek" stereotype. A quintessential "hacker" or computer "geek" is an unattractive male with poor social skills who spends hours upon hours alone with his computer working in a mathematical language. His greatest love is perhaps his inanimate machine. Given that many girls and women place a high degree of importance on relationships and express disdain for a solitary and unemotional life (Gilligan, 1982; Belenky et al, 1986), it is easy to see why most women are not inspired to delve into computer science. Turkle (1995) recounts a story about Lisa, a high school senior, who had turned away from her abilities in mathematics. "I didn't care if I was good at it. I wanted to work in worlds where languages had moods and connected you with people" (p. 53). She was equally disinterested when her teachers tried to get her interested in computer programming and mathematics by calling them languages. She wrote a poem that expressed her sentiments.

> *If you could say in numbers what I say now in words,*
> *If theorems could, like sentences, describe the flight of birds,*
> *If PPL [a computer language] had meter and parabolas had rhyme,*
> *Perhaps I'd understand you then,*
> *Perhaps I'd change my mind. ...*
>
> *But all this wishful thinking only serves to make things worse,*
> *When I compare my dearest love with your numeric verse.*
> *For if mathematics were a language, I'd succeed, I'd scale the hill,*
> *I know I'd understand, but since it's not, I never will. (p. 53).*

Turkle (1995) offers a comprehensive overview of the classical computer culture which she describes as philosophically modernist.

> As recently as ten to fifteen years ago, ... the computer had a clear intellectual identity as a calculating machine. Indeed, when I took an introductory programming course at Harvard in 1978, the professor introduced the computer to the class by calling it a giant calculator. Programming, he reassured us, was a cut and dried technical activity whose rules were crystal clear.
>
> These reassurances captured the essence of what I shall be calling the modernist computational aesthetic. ... computational ideas were presented as one of the great modern metanarratives, stories of how the world worked that provided unifying pictures and analyzed complicated things by breaking them down into simpler parts. Although the computer culture was never monolithic, always including dissenters and deviant subculture, for many years its professional mainstream (including computer scientists, engineers, economists, and cognitive scientists) shared this clear intellectual direction. (pp. 18-19).

This modernist computational aesthetic embraces many of the qualities that have previously been identified as associated with masculinity (reductionistic, linear, rational and objective). Turkle (1995) goes on to explain how this cut and dried approach alienated students whose style did not mesh with the dominant paradigm. She recounted the story of two female computer science students, one of whom was Lisa, the poet, who wanted to experiment and tinker with programming in a cyclical manner instead of create a design ahead of time and then write the code to carry it out. Their approach is labeled "soft-programming" and has been largely devalued in the computer science community since the term "soft" is associated with unscientific and undisciplined.

> Lisa and Robin came to the programming course with anxieties about not belonging because they did not see themselves as "computer people." Although both could master the class material intellectually, the course exacerbated their anxieties about not belonging because it insisted on a style of work so different form their own. Both received top grades, but each had to deny who she was in order to succeed. …
>
> Through the mid-1980s, a male-dominated computer culture that took one style as the right and only way to program discriminated against soft approaches. Although this bias hurt both male and female computer users, it fell disproportionately on women because they were disproportionately represented in the ranks of the soft masters. But even when women felt free to experiment with soft mastery, they faced a special conflict. Tinkering required a close encounter with the computer. But this violated a cultural taboo about being involved with "machines" that fell particularly harshly on women. …
>
> Many women were learning to identify being a woman with all that a computer is not, and computers with all that a woman is not. In this cultural construction, computers could be very threatening. In recent years, things have started to change. As the merging culture of simulation becomes increasingly associated with negotiational and nonhierarchical ways of thinking, it has made a place for people with a wider range of cognitive and emotional styles. In particular, women have come to feel that computers are more culturally acceptable. (excerpts from pp. 53-56).

Turkle maintains that the computer culture has changed and become more inclusive, due to the invention of the Macintosh and subsequent Windows platforms and the Internet. She contends that the easily navigated format of the Macintosh and Windows operating systems offer computer competence to a huge audience that had previously been limited to computer 'hackers' and 'hobbyists', people who thrive on understanding the machinery and the details of software functioning. She associates the newer operating systems with a postmodern computational aesthetic in which characteristics such as "decentered," "fluid," "nonlinear" and "opaque" capture the essence of computing. This stands in stark contrast to the outdated modernist paradigm and reflects characteristics that are associated with cultural construction of femininity.

Similarly, she contends that the proliferation of the Internet has transformed the nature of people's relationship with the computer from one of isolation to one of connection. She suggests that people turn to computers for experiences that they hope will affect their social and emotional lives.

> When people explore simulation games and fantasy worlds or log on to a community where they have virtual friends and lovers, they are not thinking of the computer as what Charles Babbage, the nineteenth-century mathematician who invented the first programmable machine, called an analytical engine. They are seeking out the computer as an intimate machine (p. 26, Turkle, 1995).

These cultural transformations of the computer culture, she suggests, are breaking down the link between computers and masculinity. Others agree with her. In one study, Macintosh computer ads in technology magazines did not stereotype male and female computer use and competence while PC advertisements did (Weinstein, 1998). Other research suggests that the Internet, in particular, serves as an entrée into the computer culture for those who enjoy the unique opportunities for communication and collaboration that it provides (Brunner & Bennett, 1997; Furger, 1998, Riel, 2000). So, there is evidence to suggest that new paradigms for the computing culture, brought about by a user-friendly interface and the Internet, are promoting a more inclusive culture.

However, others disagree. The AAUW (2000) report indicates that girls continue to view the computer culture, including the Internet environment, as predominately male and anti-social. Girls have expressed the sentiment that boys use the Internet to escape from real relationships and that girls have better things to do with their friends than spend all their time on-line (AAUW, 2000). This attitude reflects the notion that girls are less likely to be consumed by computer environments than are boys (Turkle, 1986; 1995). According to this report, while girls indicate they like to use the computer for communication, this does not necessarily mean that girls no longer feel a conflict between femininity and computing.

However, the possibility that there is an Internet culture that differs from the computer science culture seems plausible. The focus of these two enterprises is so different that it seems reasonable to separate them. Since the classical computer science culture is well documented, further examination of people's perception of the Internet culture would help illuminate this issue.

The Intersection of Gender, Science and Computer Technology

The gender equity literatures in science and computer technology share some common goals. The works examine how the cultures of scientific and computer technology communities create climates that are open and closed to different groups of people. They contend that cultural barriers, not innate or biological differences, are responsible for disparities in achievement and participation. Today, both literatures suggest that it is not the girls who need to catch up with science or computers, but that science and computers need to catch up with them (AAUW, 2000). In other words, girls' legitimate concerns should focus attention on changing the software and curricula, pedagogy, and goals for science and computer technology education (AAUW, 2000). A successful transformation would enable more women and other reticent groups to visualize themselves as legitimate participants and those fields as interesting and meaningful. The literatures share the belief that increasing the participation of women in scientific and computer professions will benefit the fields by bringing in more diverse perspectives (AAUW, 2000; Rosser, 2000). Both argue that changing educational practices, curricula and culture will ultimately benefit both the "haves" and "have-nots" by creating more opportunities for engagement, and will not eliminate what has worked for those already engaged.

While the literatures suggest that the science and computer science cultures are stubbornly masculine, whether this is true for the Internet culture is under debate. Does the use of computer technology and the Internet in science class compound these notions of masculinity and fail to expand students' interests in scientific topics? Or does the Internet culture offer a significant change in the nature of computing and participating in a scientific community which has the potential to positively affect student interest and achievement?

These questions are central to the conceptual framework that guides this study. The scientific and computing cultures are two of the four cultural and psychological influences that contribute to girls' lagging interest and achievement in science in this framework. When the masculinity of these cultures intersect with gender-biased classroom experiences and the intense initiation into femininity that accompanies adolescence, middle school girls are at an exceptional disadvantage when it comes to maintaining any interest and talent in science they have. The goals of the current science education reform movement identify gender inequity as an important area on which to concentrate improvement efforts. Therefore, this study examines whether the use of an Internet-based science curriculum project in a middle school science classroom has potential to aid this effort to improve the participation, interest and achievement levels of girls in secondary science.

CHAPTER 3: METHODOLOGY

Introduction

Ethnographic and case study research methods are used for data collection and data analysis in this study. Spradley's (1980) how-to book entitled *Participant Observation* provides detailed guidelines for data collection and analysis. Yin's (1994) book, *Case Study Research: Design and Methods* complements Spradley's and is used to inform the examination of the participants in this study as case study subjects. Qualitative methodology books by Yin (1994) and Spradley (1980) complement one other in that they suggest many of the same strategies for data collection and analysis. They both allow for an exploration of students' experiences in one particular setting that provide in- depth data regarding the topic. Since Spradley offers a more detailed list of procedures in the data analysis phase than Yin and since I previously used *Participant Observation* in an ethnographic methods course, Spradley's methodology is followed most closely in this study.

The Research Site

This research was conducted during the science period in one sixth grade, middle school classroom in a community near a large mid-western city. There were 23 students and one teacher in this classroom. This class participated in an Internet-based science project called Journey North for roughly five weeks in the spring of 2001. The project runs for four months, February through May, so this class only participated in a fraction of the project. The class used the school's computer lab for the Internet aspects of the project and remained in their science classroom for noncomputer project activities. I visited the class for the five weeks they participated in the project.

Participants

All students were invited to participate in the study. Students who agreed to be videotaped and submit their work for review signed an assent form and their parents signed a consent form in keeping with the Human Research Committee guidelines. Students and/or their parents who did not sign a form were excluded from all data collection in this study. Five students were selected with help from the classroom teacher and invited to serve as focus students in this study. In addition to participating in the same ways as their other classmates, these students also agreed to be interviewed individually at the end of the project.

The teacher was also a participant in the study who signed a consent form to be videotaped, interviewed and observed in her classroom and computer lab. Pseudonyms are used to protect the anonymity of the participants.

Research Questions

The research questions for this study are divided into three main sections that reflect the organization of the conceptual framework. The first focuses on developing an understanding of students' experiences and beliefs in the classroom context. The second examines issues relating to femininity, women's ways of knowing and adolescent development. The third focuses on the intersection of gender and the science and computer cultures. The following table provides a list of these research questions and how they relate to the conceptual framework. Note that each question is grounded in a particular section from the conceptual framework that is listed on the right.

Table 3.1: Research Question Overview Chart

	Research Questions	Conceptual Framework Section
Classroom Culture	How do classroom dynamics influence girls' and boys' participation? • Teacher-student interactions • Student-student interactions	Classroom Culture
	What does the teacher say about gender differences in science and computer technology? • Does she observe any differences between groups of boys and girls in terms of participation, interest and learning? • What kinds of variations does she note?	Classroom Culture Gender and Computer Culture
	How do students view science, computer technology and the Internet with regard to gender? • Do students observe any differences between boys and girls in terms of participation, interest and learning in science? In the use of computer technology? In the use of Internet technology? • Are course materials gender-biased? • Is their teacher gender-biased?	Feminist Theory and Science Classroom Culture Gender and Computer Culture
Adolescence and Gender	In what ways, if any, do the girls in the classroom indicate that adolescence is a cultural initiation into femininity? • In what ways do girls enact feminine stereotypes in the science classroom and computer lab? • In what ways do they resist these stereotypes?	Adolescence- A Cultural Initiation
	Does the notion that girls are motivated by human connection seem to hold true when the Internet is used in the science classroom for communication and collaboration?	Women's Ways of Knowing
Science and Computer Culture	How does the science content under investigation in computer activities influence girls' and boys' interest and participation?	Gender, Science and Computer Culture
	How do Internet computer activities influence student participation and interest in science activities?	"
	In what ways, if any, do students find that the Internet culture differs from the larger computer culture?	Gender and Computer Culture

Methods of Data Collection

The specific data collection methods used include *classroom observation and field notes, a journal* which records my thoughts regarding the research setting, a whole class *questionnaire*, and *interviews* with five case study students and the teacher, and *document review* of relevant curricular materials and student work.

Student participants were video taped during class sessions in the regular classroom and in the computer lab. The interviews were audio taped. All tapes were transcribed.

Classroom Observation

Data collected during classroom observations were integral to this study. Time spent as a spectator in the classroom allowed for observation of students' interactions with each other, their teacher and the curriculum. Data from classroom observations included field notes and a personal journal.

Field Notes

My field notes chronicled the detailed aspects of the activities in the classroom. The following list of observation guidelines informed my field notes and helped me be consistent in my observations.

- Describe the class environment.
    - How is space arranged and used (i.e., student seating, small group formation, teacher's movement in the class)?
    - What are the rules in the classroom and computer lab?
- Describe the class activities.
    - What are the tasks?
    - What does the teacher say to students?
    - How do students interact?
- Describe student engagement.
    - What do students accomplish?
    - What do students say (about the tasks, science content, Internet activities and about others)?

I posted this list of observation guidelines in the front of the notebook that I took with me each time I visited the classroom. The description of the class environment was discussed in my initial visits only. Descriptions of the teacher and students' activities were noted during each visit.

Journal

The journal records my personal thoughts, reactions and comments regarding my experiences there. The journal played a more minor role than the field notes in the scheme of data collection, yet it allowed me to periodically review my personal impressions and highlighted issues that were important to me at the time.

Whole Class Questionnaire (Appendix A)

To address the research questions from many angles, a Likert-scale questionnaire was administered to the whole class regarding their beliefs and experiences related to the research questions at the end of the project. Students were asked to select a number from 1 to 5 indicating whether they agreed or disagreed with the statement. I created this questionnaire by formulating questions related to the research questions primarily from the 'classroom culture' and 'science and computer culture' sections found in Table 2. I decided not to ask any questions about their experience as adolescents since I do not think they have a broad enough perspective with which to view and discuss their present life stage. The questionnaire explores students' interest in science, computers and Internet technology, views of their classroom culture, and views of gender issues with regard to science and computer technology.

Tabulations of these questionnaires provided some useful but limited information by which to compare and contrast the focus students' responses and comments during the interviews and class sessions. It is not featured as a major source of data in the findings chapter, but some responses are woven into the presentation of data. The tabulation of student responses is attached following the questionnaire in Appendix A.

Interviews (Appendices B and C)

Interviews with the focus students and the classroom teacher were one of the most significant pieces in the data collection. Individual interviews allowed opportunities to ask specific questions related to the research questions and to probe the participants to elaborate on phenomena I observed during classroom observations. These individual interviews provided the most direct answers to questions in this study.

Participants were interviewed at the end of the Journey North project, which was also the second to last week of the school year. Students were interviewed during science class but in a private room in the counseling office at a time approved by the classroom teacher. The interviews were both audio taped and videotaped and transcribed.

Document Review

Another part of data collection included review of the Journey North curriculum, activities created by the teacher, and the Internet-based activities students completed on the Journey North website. These documents were reviewed in light of the research questions. Focus students' work was also collected and reviewed to describe the nature of student participation, interest and learning. Other artifacts such as email correspondences were also collected.

Relationship between Research Questions and Data Collection Instruments

The following chart provides a detailed overview of the data collection methods that were used to address each research question. The exact pieces of each methodological protocol designed to address the corresponding research question are listed in the Methods of Data Collection column on the table.

Table 3.2: Methods of Data Collection for Each Research Question

	Research Questions	Methods of Data Collection
Classroom Culture	How do classroom dynamics influence girls' and boys' participation? • Teacher-student interactions • Student-student interactions	Observation • Describe the classroom environment. • How is space arranged and used? • What rules in the classroom and lab influence student participation? • What does the teacher say to students? • How do students interact? • What do students say? Questionnaire - In my science classroom, boys and girls participate equally when working together in small groups. - At my school, many students think girls are not supposed to like science. • At my school, many students think girls are not supposed to do well in science.
	How do social structures in the computer lab influence boys' and girls' participation?	Observation • Describe the computer lab. • How is space arranged and used? • How do students interact? • What does the teacher say to students? Questionnaire • In the computer lab, boys and girls participate equally when working together in small groups. • At my school, many students think girls are not supposed to like computers. • At my school, many students think girls are not supposed to know a lot about using computers.
	What does the teacher say about gender differences in science and computer technology? • Does she observe any differences between groups of boys and girls in terms of participation, interest and learning? • What kinds of variations does she note?	Observation • What does the teacher say to students? Interview • Do you observe any differences between boys and girls in terms of participation, interest and learning in science? In the computer lab? If so, elaborate. • What are some exceptions? • Do you think there is any distinction between students' interest in Internet technology and other types of computer technology? • Do certain types of students seem to enjoy one more than the other?

	How do students view science, computer technology and the Internet with regard to gender? • Do students observe any differences between boys and girls in terms of participation, interest and learning in science? In the use of computer technology? In the use of Internet technology? • Are course materials gender-biased? • Is their teacher gender-biased?	Document review of course materials Interviews • Do you think there are any differences between boys and girls in terms of interest and learning in science? If so, why? How about in computer use? Is the Internet any different? If so, why? Questionnaire - Girls and boys are equally talented in science. - Girls and boys are equally talented at using computer technology. - My science teacher thinks boys and girls are equally talented in science. - My science teacher thinks boys and girls are equally talented in using computer technology. - In my science classroom, boys and girls participate equally when working together in small groups. - In the computer lab, boys and girls participate equally when working together in small groups. - In my science class, our course materials make it seem like men are better at science than women. - Course materials for computers make it seem like men are better at computers than women.
Adolescence and Gender	In what ways, if any, do the girls in the classroom indicate that adolescence is a cultural initiation into femininity? • In what ways do girls enact feminine stereotypes in the science classroom and computer lab? • In what ways do they resist these stereotypes?	Observation • What do students accomplish? • What do students say (about the tasks, science content, Internet activities and about others)? Interviews • Potentially all questions Questionnaire • At my school, many students think girls are not supposed to like computers. • At my school, many students think girls are not supposed to know a lot about using computers.
	Does the notion that girls are motivated by human connection seem to hold true when the Internet is used in the science classroom for communication and collaboration?	Observation • What do students say (about the tasks, science content, Internet activities and about others)? Interviews • Tell me about your interest in using Internet technology, in particular. • What do you like and/or dislike about the ways you use it? • Do you think it is different from other types of computer activities? Why or why not?

Science and Computer Culture	How does the science content under investigation in computer activities influence girls' and boys' interest, participation and learning?	Document review of student work
		Observation
		• What do students say (about the tasks, science content, Internet activities)?
		Interviews
		• Tell me about your interest and learning in science class.
		    • Do you like science? Why or why not?
		    • Do you understand what you learn in science? Why or why not?
		• How does participating in this science Internet project compare to using the Internet in other classes or for other science units? Is it more or less interesting? Why?

	How do Internet computer activities influence student participation, interest and learning in science activities?	Observation
		• What do students say (about the tasks, science content, and Internet activities)?
		Interviews
		• Tell me about your interest in using Internet technology, in particular.
		    • What do you like and/or dislike about the ways you use it?
		    • Do you think it is different from other types of computer activities? Why or why not?
		• How does participating in this science Internet project compare to using the Internet in other classes or for other science units?
		    • Is it more or less interesting? Why?
		Questionnaire
		• I enjoy using the Internet.
		• I enjoy using email.
		• I like using the Internet and email more than using other types of computer technology.
		Document review of student work

	In what ways, if any, do students find that the Internet culture differs from the larger computer culture?	Interviews • Tell me about your interest in using Internet technology, in particular. • Do you think it is different from other types of computer activities? Why or why not? • Do you think there are any differences between boys and girls in terms of interest and learning in science? If so, why? How about in computer use? Is the Internet any different? If so, why? Questionnaire • Anyone who likes using computers would also like using the Internet or email. • Anyone who likes using the Internet or email would also like using other types of computer technology.

Methods of Data Analysis

Spradley's (1980) semantic structure analysis method as described in the *Participant Observation* was used in this study. In general, this analysis method is designed to illuminate patterns and anomalies in the data through various, systematic reviews of the data. Reviewing the data in multiple ways and identifying patterns present in the data help build a case for the conclusions from data analysis. In the following few paragraphs, I describe each of the analysis methods used to explore the data.

I began by creating a *domain analysis* (Appendix D) for each data set (field notes, interviews, etc.) in which I read through the documents and generated cover terms that captured as many themes in the data as I could find. These cover terms are nouns that reflect major players or ideas in the data (e.g., student, teacher, computer program…). Next, I organized these cover terms and listed as many included terms, or words and phrases that describe these cover terms in more detail, under them. The descriptions relate to the cover term through a particular semantic relationship (e.g., x is a kind of student, x is a characteristic of the teacher…).

Next, I performed a *taxonomic analysis* (Appendix E) in which I organized these cover terms and included terms into a hierarchical form. This allowed me to combine similar domains into one large outline of themes and their components. Spradley (1980) includes an example of a taxonomic analysis of "kinds of parents". One kind of parent is labeled a "teacher." Included terms are listed in a hierarchy.

Kinds of parents

1. The teacher
    - 1.1 the knowledge sharer
    - 1.2 the lecturer
    - 1.3 the tutor
    - 1.4 the question-answerer

1.5 the discussion leader
2. Etc. (Spradley, 1980, p. 118).

This method of analysis allowed me to organize all the major cover terms into a meaningful order that kept the main ideas organized and visible. Terms were added to the taxonomic analysis as they arose during my repeated reviews of the data.

Finally, I performed a *componential analysis* (Appendix F) on these data in which I compared and contrasted several main themes across data sets. In this analysis, I show patterns represented by many, if not all, of the students. I also searched for differences among participants and among data sets. These analyses were organized in a variety of tables. This helped illuminate similarities and differences among participants.

Reliability and Validity

Methods to improve the reliability and validity of ethnographic and case study research methods have been identified by numerous methodological experts in the field. Yin (1994) offers specific examples for research design that address construct validity, internal validity, external validity and reliability in his book *Case Study Research: Design and Methods*. Many of his suggestions reflect the methodology outlined by Spradley (1980) that I followed most closely in this study. I will discuss how reliability and each type of validity are or are not addressed in this study.

Construct Validity

Construct validity refers to how well the study is designed to accurately report observed phenomena instead of relying solely on the researcher's subjective judgments. The first way that construct validity can be strengthened is through the use of multiple sources of evidence (Yin, 1994). In this study, triangulation of data (participant observation, interviews, anonymous questionnaire, and document review) was used in the design to yield multiple perspectives of the same phenomenon. These multiple sources of evidence strengthen the case that reported results were observed in a variety of instances (Yin, 1994).

Yin (1994) also suggests that construct validity is strengthened when facts reported by the researcher are reviewed and corroborated by participants. This method entails having participants read drafts of the written report and comment on areas in which they agree or disagree with the researcher. It is especially important that participants agree with the facts presented, but it is not necessary that they agree with the conclusions (Yin, 1994). Student participants in this study did not have the opportunity to read any parts of this report since the school year was over at the end of data collection. I did not try to follow up with them during the summer or the next school year. The teacher responded to my componential analysis and clarified my perceptions of how often each student participated in whole class discussions. This was helpful in that my observations were based on only a few weeks of time in the class and she corrected my observations in light of participants' levels of participation throughout the school year. I did not, however, have the teacher read my entire study. I had concerns that my critiques of her enactment of the project might jeapordize or strain our family friend relationship.

Internal Validity

Internal validity is concerned with whether the conclusions or inferences from the data are accurate (Yin, 1994). Internal validity is flawed when the researcher makes a casual attribution incorrectly. Two of Yin's suggestions to strengthen internal validity were employed in this study. The first was the use of a variety of data analysis procedures. In this study I followed Spradley's (1980) detailed analysis procedures to create a domain, taxonomic and componential analysis. Analyzing data from multiple perspectives helped identify patterns and exceptions in the data. Secondly, I suggested alternative explanations for conclusions or inferences made from data collection and anaysis where possible as suggested by Yin (1994).

External Validity

External validity is concerned with whether conclusions can be generalized beyond the immediate study. Yin (1994) points out that case study research (and therefore other types of qualitative research) cannot generalize to other situations as can studies with statistical generalizability. Instead, case studies rely on analytical generalization in which conclusions can generalize only to theory (Yin, 1994).

This principle is followed in this study as I do not suggest that the same conclusions would be found in other settings. Instead, I provide in-depth information about the participants in this setting and relate my conclusions to the literature reviewed in the conceptual framework for the study.

Reliability

Finally, reliability refers to whether the same conclusions would be drawn if the same case study was repeated. Yin (1994) suggests that reliability can be improved by following a detailed research design. This was accomplished in this study through a close following of Spradley's (1980) methodology. Yin (1994) also suggests that researchers maintain a database that can be reviewed independently so readers can confirm the researchers' conclusions and so the analysis can be replicated. While raw data is not included in the appendices of this study due to space and anonymity considerations, it is available upon request.

Threats to Validity

Qualitative research harbors unique threats to validity that derive from the participation of the researcher in the research setting. One concern is *reporting bias* (Yin, 1994) in which the subjectivities of the researcher determine what data are collected, analyzed and presented. Another concern is *reflexivity* (Yin, 1994) in which participants act differently because they are being observed or interviewed. For example, an interviewee may tell the researcher what s/he thinks the researcher wants to hear instead of an honest opinion. Or, events in a study may proceed differently because the researcher is observing or participating in the events. These threats are part of the nature of qualitative research and are helped, in part, by the researcher identifying his or her personal biases and involvement in the research setting.

The Role of Researcher

My role with the classroom teacher, Laura, and in the classroom setting evolved throughout the research process. In the beginning, I tried to remain more of an observer than a participant-observer but this did not last long. Laura asked for help organizing the curriculum before she began and I made suggestions as to what she should do. Later during the data collection phase I wrote several lessons plans and presented some activities to the class with which Laura was unfamiliar. While students worked in the computer lab, my role evolved from an observer to a participant as well. There were too many student questions for Laura to address alone, so I assisted students too. I felt that the students and Laura would have a better learning experience if I participated.

My role as a participant certainly changed the outcome of the research setting in that the teacher would not have undertaken Journey North at all or to the degree she did without my participation. Similarly, my involvement with students also redirected some events in a direction I believed to be more educational. However, I did not undertake this project with an agenda to educate students about gender differences, educational technology or subject matter. While I did seize opportunities in which I helped students learn about computers and to a lesser extent, subject matter, I did not make any attempts to educate students about gender differences. A discussion of gender differences did arise once with the teacher however, when she brought it up herself. The instances in which I became an active participant are clearly presented in Chapter 4.

Additionally, my personal lens as a researcher undoubtedly influenced my interpretations of my experiences in the research setting in ways both known and unknown to me. This lens has been formed by my experience as an adolescent girl and woman in our society, as a student, and as a middle school science teacher.

My experience as an adolescent girl reflects the literature reviewed on the challenges of adolescence in many ways. I hated those years; I felt insecure, I focused too much on my appearance, and was paralyzed in many ways by a learned lack of assertiveness.

My experience as a female science student also reflects much of the literature on the influence of classroom culture on confidence and achievement. I took science classes throughout my secondary school years, though the numbers of girls kept dwindling each year. I spent a lot of time flirting with boys in science class and I did not always feel confident in my understandings of the concepts presented. This was especially true in chemistry and physics. I assumed that several of the boys in my class were inherently smarter than me in science and math, though I didn't think this in English. I struggled in my senior year physics course, and upon reflection, my attempts to ask the teacher for help after school were met with a nice but patronizing and complacent attitude that if I didn't already get it, there probably wasn't much hope for me. These experiences have shaped my interest in studying gender differences in school and science in particular.

I discovered what a strong interest I have in science topics as a middle school science teacher just out of college. I found that science class could be extremely interesting to students if presented as relevant to their daily life. Therefore, I have an opinion about how science is best communicated and taught to students, especially at this level. Additionally, my experience as a teacher who used computer technology in the classroom predisposes me to certain beliefs toward the benefits of using computer technology in the classroom. My experiences were mostly positive and my enthusiasm for technology is high. In sum, all of these personal experiences shape my observations, analyses and interpretations in ways that may not always be clear to me.

CHAPTER 4: FINDINGS

Introduction

Description of the Research Site

This study was conducted in a sixth grade, middle school classroom in a rural/suburban community outside a large mid-western city. The teacher in this classroom, whom I will call Laura, worked on a team of three teachers. There were seven sixth grade teachers in the middle school that comprised sixth, seventh and eighth grades. Laura taught math to the whole team while the other two teachers taught language arts and social studies. Each teacher taught science and reading to her homeroom class. The school day was divided into seven periods and science class was scheduled for the last period of the day.

Green Valley, my name for the city in which this school was located, used to be strictly rural but as development has encroached on the town, the population and feel has become much more suburban. The school district is small with one elementary, one middle and one high school in the town. However, the school is medium-sized. There are about 170 sixth graders and close to 500 students in the middle school. The community can be characterized as predominately white and middle class. The school has less than 10% of its students on free or reduced lunch and its population is 95% white. There are a few Hispanics and few, if any, African-Americans.

As a result of rapid population growth in the area, the district built a new high school and the middle school is housed in the old high school. Laura's classroom is located in a mobile type unit outside of the main building. There are two of these large outside structures that house many classrooms and the cafeteria. Laura complained that her classroom was run-down and junky. An accordion door separated her room from her teammates' room next door. This door provided only mild sound-proofing, and therefore the classroom could be quite noisy if the students were working together next door.

There was one computer and one printer by the teacher's desk. Several teachers in the outside unit shared this printer. During my five weeks in the classroom, I did not see Laura or any of her students use this computer. The school had one computer lab located inside the main building. A full-time computer teacher had his desk in this room. Some periods of the day were set aside for keyboarding and computer classes; the others were available to teachers.

The Journey North Project

Laura agreed to participate in the on-line Journey North Project at my suggestion specifically for this research project. Journey North (http://www.learner.org/jnorth) is a coordinated, Internet-based project that follows multiple animal and insect migrations and other signs of spring from February through May each year. Thousands of classrooms across the country and from Canada and Mexico participate in this collaborative project. The following introduction from the Journey North Teacher's Manual provides a succinct overview of the project.

> Annenberg/CPB is pleased to present Journey North, an annual Internet-based learning adventure that engages students in a global study of wildlife migrations and seasonal change. Beginning every year around Groundhog's Day (February 2), students travel northward with spring as it sweeps across the continent of North America. With global classmates and state-of-the-art

> computer technology, they predict the arrival of spring from half a world away.
>
> Up to the minute news about a dozen migrations is exchanged between classrooms as students report observations from their own hometowns. The dramatic journeys of several animals is tracked by satellite. News will travel from the animals' transmitters to an orbiting satellite and then directly into the classroom via the Internet. This revolutionary technology gives students a bird's- eye view of the remarkable challenges faced by animals as they travel.
>
> Linked to classrooms from the Tropics to the tundra, students will also conduct interactive, comparative studies of the natural world. In addition to the following migrations, they will observe the local emergence of spring through studies of changing daylight, temperature and other signs of spring. For example, students will proclaim the official arrival of spring when tulips bloom in their communities. In this and other "Spring Fever" projects, classrooms investigate the relationship between geography, temperature and the arrival of spring. Together students gather, organize and analyze their own data. Using the Internet, they can fit their local observations into a global context – essentially seeing that their small part of the world is part of a large, natural system. (Howard & Wiley, 2000, p. 2).

While the project offers study of a variety of species (e.g. monarch butterflies, bald eagles, humpback whales, manatees, loons, robins, whooping cranes, orioles and hummingbirds), the authors suggest teachers working alone follow two or three migrations and local signs of spring such as when trees leaf-out and tulips bloom. This approach allows students some variety in what they study and encourages them to connect local observations with larger patterns across the continent. In addition to using data posted by other classrooms, the program suggests teachers connect with other teachers and organize communication between their students about questions and small comparative projects they generate themselves. Journey North provides scientific experts for students and teachers to communicate with as well. These professionals write parts of the weekly migration updates and answer questions directly from students about their area of expertise. The teacher's manual and website (http://www.learner.org/jnorth) also offer activities that encourage critical thinking about data collection, data analysis and the sharing of scientific results and information.

Focus Students

Five students participated as focus students for this research project. Laura and one of her teammates helped select two boys and three girls who would be interesting participants because of their individual personalities and because they represent a diversity of attitudes toward science and computer technology. I observed and videotaped these five students working in the computer lab and in the science classroom and interviewed them individually at the end of the project. I also interacted with these students more than with others by assisting them in the lab and talking with them casually. The following descriptions serve as an overview of these students' personalities and attitudes that will help frame the subsequent findings presented in this chapter.

Sally

Sally was chosen to participate because she made it clear to Laura that she did not like computers and was not enthusiastic about the Journey North project. However, science and social studies are her favorite subjects and she especially enjoys hands-on projects in science. During the interview she said she only "sometimes" understands what she learns in science. Sally had a negative experience with computers in elementary school. Her class used tutorial programs for reading and math; she described her frustration with them in the interview.

> Sally: Well, the reading comprehension is just, if you were having a hard time in reading you would have to go, we'd go in there for about an hour. And

> you'd have to go for thirty minutes reading and then thirty minutes math. And I liked the math section more than the reading because I don't like reading. And most of it was reading a paragraph and then answering questions, and I had (I was one of the lower students) I didn't, you know I don't like to read. I didn't really comprehend that much.
>
> Megan: So it was kind of, you would just go in by yourself and work….
>
> Sally: Well actually we would go in with the whole class and everyone had to go in and if you were really good at the reading you'd only have to go do the math. Or if you were really good at math, you'd do reading. But I had to do both. And sometimes if you were really good, like we had to go twice every week I think it was, and I would do math for one, I'd do math and then reading, and then the other time reading and then math, and then if I had extra I could go into a game. And just play games. Or it would stop you in the math or stop you in reading and it just takes you to a game. And then you go, when the game's over you click and then you go to your math session or your reading session.
>
> Megan: Is there anything that you liked about doing those kind of programs on the computer?
>
> Sally: I liked the math. I didn't like the reading. Not much.
>
> Megan: Just because you liked math better? [Sally: "Yeah."] Was there anything that you just didn't like about using computers like that?
>
> Sally: I never did like computers because I thought they were complicating to get through, and so I never used computers except at school. And when we did, I just always complained, I didn't like the computers. I just hated it in there, because some kids would get done early, like some kids would get done in 30 minutes, and the session was over and then they have to go sit on the wall. And I was never one of those. I was always the one having to stay like five minutes after our session was over to finish, because it times you and if you're doing bad they go over time. So it was really bad for me. [Megan: "It was frustrating?"] Yeah. I didn't like it.

Sally exhibited a lack of confidence with computers and often downplayed anything she did know about computers. She said "I don't know" more frequently than the other focus students when they worked together in a group and seemed to lack confidence in her opinions and knowledge. I observed Sally to be socially adept, well-liked by Laura and her classmates and easy to get along with. Laura offered the following description of her.

> Sally is just the good, all-around kid. *Very* average student. I mean, very average. I'm not sure if Sally could do more, or Sally just, that's just kind of what Sally chooses to do. Sally loves school this year. She does not want school to be over. ... She's just one of the nicest, neatest, she's another one that is so artistic. I mean super artistic. And will make you just wonderful drawings and all of this....
>
> I would say in science though she's just a very, very average student. And I don't know that she's a slacker, I really haven't quite figured her out. I think she probably could do better than she does. I think sometimes she slacks, sometimes she doesn't. But she's, she seems to be, I mean if you had a whole classroom of her, she's just a dream to work with. I mean she really is. So apparently, I haven't motivated her, though, to get to that higher level.

Sally is very nice, and prides herself on that quality. During one science unit she and another girl were grouped with a boy in class whom no one could get along with. Laura recounts the story:

> Oh, when she was working with Rachel, they were working on their bridges. And they were in a group, and they were with *Kurt*. And so they wanted to know if they could come in one morning and talk to me. So they came in and they were like, he is *impossible* to work with. And Sally goes, "I'm always so nice. I always get put with people I can't work with" [Laughter.] Oh, you're right!!! I mean, you know, she is, because she is the peacemaker, would not hurt anybody's feelings or anything.

In many ways, Sally exhibits behaviors and attitudes that mirror the adolescent and gender studies reviewed earlier that chronicle girls' loss of 'voice' and confidence and desire to be nice above all else. As I will discuss later, Sally demonstrates that these qualities earn high marks with teachers and friends but can undermine academic performance.

Jenny

Jenny is a very quiet girl who does well in school. She was chosen as a participant because she showed an unusual interest in the oriole (the migration the class was following in the Journey North project). Her grandmother is a birdwatcher and this had sparked Jenny's interest. Toward the beginning of the project she brought in an oriole's nest her grandmother had kept. While Jenny is very quiet, she is also very conscientious and always asks for help when she needs it. She participates in class by asking questions and Laura often asks for her input during class discussions because she thinks Jenny has a lot to offer. I never observed Jenny raise her hand to offer information, only to ask questions. Laura offered the following description of Jenny.

> Quietest little thing, *sweetest* little, oh she's just one of the sweetest young ladies. She's somebody that gets her work done all the time. Very conscientious. Asks questions in class though. I mean, as quiet as she is she will always ask in class, she participates. You have to listen very carefully but she's got a whole other personality because she and her friends, and she has two little girls she runs around with, they will come back and they will just be giggling and having silly little things, and you know she always comes up at the end of the day and, you know, "Have a good evening." I mean, just so thoughtful of other people.
>
> As a student, she really works. I don't think Jenny is overly bright, but Jenny is definitely on the principal's honor roll just because she never misses an assignment. It's like her report was in two days early. So, so focused on everything. A little bit of her personality—we went to the zoo and she comes up and she says, "Now, if somebody cuts himself I have Band-Aids for everybody. I just bring Band-Aids." She said, "I always do on a field trip." [Laughter.] I mean, she's the most, she's the most thoughtful...she would not hurt a person's feelings for anything. I mean, she's just super artistic, just a lot of, there's a lot of talent.... There's a lot more depth to Jenny than we give her credit for. There really is.... She's really a unique person. I don't know that I've had one quite that shy with that much going for her. Neat gal.

In my interview with Jenny, she indicated that she likes science and computers but likes hands-on science projects best. Designing and building simple machines was her favorite unit because they "got to crush the cans." She always chose to work independently in the computer lab and indicated she liked that feature of the Journey North project.

> Jenny: I think [Journey North] was a little bit easier, instead of doing [projects] in class, because sometimes other kids in the classroom are a little bit loud, and everybody's quiet like on the computers.
>
> Megan: Because they're sitting there reading it?
>
> Jenny: Uh huh.
>
> Megan: Okay. So you like that? You like working by yourself and having it kind of quiet?
>
> Jenny: Uh huh.

Like Sally, Jenny is described as being a very sweet and nice girl. While she also is passive in group settings, Jenny has more confidence in her own opinions and abilities. She likes computers and feels she is good at using them. Similarly, she is confident about her abilities and comprehension in science and takes learning new things in stride. She had never used email before this project and needed quite a bit of help in the beginning, yet exhibited a positive attitude toward this learning experience.

<u>Hannah</u>

Hannah is a confident, outgoing girl who excels in school. She is experienced and competent with computers and enjoyed the Journey North project as much as the hands-on projects they'd done in class. She exhibits a positive attitude and participates more in class and in small groups than Sally or Jenny. Laura offered the following description of her.

> Well, Hannah is a new student. She's been here half a year. She excels in everything she does. She struggles more in math than anything. Seems to have a really neat, extensive science background. She is an avid writer, she just writes, oh she's like writing a chapter book. And she ran for student council president and had just an outstanding speech. Very focused. I think she gets quite a bit of help at home. Science is definitely strong for her, but along with reading and language arts. She's an A student except math, and she's high B. I'm recommending her for advanced math class. She really works at it. Not afraid to ask a question at all. Just kind of a dream student to have. And so articulate. Very articulate. ... She just seems really focused. I mean she seemed anxious to come over [to the computer lab]. Interested in doing the project, very happy that she was going to be one that we were going to talk to; just really excited about it. But I think she's excited about anything she does. That's her attitude.

As I observed her in the computer lab, she was comfortable working alone and with a partner. She and Sally worked together some toward the end of the project. She was very socially adept like Sally, but more assertive in her interactions with others and less of a caretaker and peacemaker. She was also once grouped with Kurt, the difficult boy, and had a somewhat different interaction with Laura about it.

> Laura: Hannah is just a really a pretty positive person. I've only heard her one time; it was with Kurt [laughing]. And he was driving her nuts. "I cannot work with him." I mean, she was just, "I cannot work with him. There's no way. Don't even ask me to try. I cannot work with him." [Megan: "Good for her!"] You know, absolutely. And you want to look and say, "I can't either!"

While not dramatically different, Hannah resisted female stereotypes more than the other two female focus students. Her actions and interactions are interesting to examine in this regard.

John

John was recommended to participate because he was the top science student in class and fit the male science-lover stereotype to a tee. The following highlights of Laura's description of him during our interview paint a strong picture of John.

> Laura: John is an interesting person. I mean he comes across as almost a nerd type thing. Not into fashion by any means. I mean he may wear the same shirt every day. John comes from a very caring, strict family. I think probably economically challenged but not that they are deprived of anything at all.... Very bright kid. In science, in math I think he may be my class high. I mean of all three classes. Science, he runs 98, 99. Very, very high. If you want to know something, you can pretty well ask him. And he comes up with weird detail. I mean, he'll know this little trivia and all that kind of stuff. And he kind of prides himself in that. He's a pretty nice kid. I shouldn't say pretty nice. He's a real nice kid overall. But he's kind of a loner. Nothing like Kurt. I mean kids don't mind working with him or anything like that. But, he pretty well does his own thing.
>
> Megan: Does he have friends?
>
> Laura: Yes, but, close friends that he would go to somebody else's house with, if he does I'm not aware of them. Not in our class. But is he included in things? Yeah. But I mean, if they had a party or something he would not be invited at all.

John exhibits traditionally masculine interests in science and technology to a degree that is striking in comparison with the other focus students. Several examples of this approach arose during my interview with him. When I asked him about his experience with computers he replied:

> John: Well, I took computer classes, and I know that there are four functions that a computer must do to be a computer. [Megan: "Okay, what are those?] First, it must accept input, generate output, process, and process information....I forgot what the other one is.
>
> Megan: That's all right.

In this excerpt, his conceptualization of computers reflects the "masculine" modernist computational aesthetic presented earlier in which complicated things are best described as the sum of their parts. In the following excerpt, he uses the vocabulary of a scientist.

> Megan: Okay, anything else that you think doing on the computer has helped you learn?
>
> John: Well, I think it helps you to, you know, like stimulate, to get more precise locations, because with a computer you have to have pretty much the precise location of the web address, and if it isn't correct, the computer will say, "Sorry, could not find."
>
> Megan: So how does that help you, do you think?
>
> John: I think it helps you to learn to be more *precise*, and get more *accurate* information (emphasis his).

In this final exchange, John's interests reflect some of the literature reviewed earlier on gender differences in the use of computer technology.

> Megan: Okay. So are they (hands-on science projects and computers) both interesting to you? Or is one more interesting than the other?
>
> John: I think that the computer is a little bit more because, you know, at my age you're wanting to deal with electronics and stuff like that.
>
> Megan: So you like just fiddling around on the computer and learning about it?
>
> John: Yeah.

Finally, at the conclusion of the interview, John implied that Journey North was a good project because he wants to be a scientist when he grows up.

> John: I think it's a good way for young kids who want to grow up to be scientists to learn what information you need to have written down when you're studying a creature or animal. Like the golden tamarin lions, they're actually these little monkeys, and they were recently considered to be almost extinct. There's only like twenty or so in the wild. And now scientists have learned to study them, and in one case they found out that the tamarins would only go out like three or four branches further than what they did the day before. And it's like, okay, so this area is safe, let's check out a little further.

> Megan: So you like that, learning about animal behavior [Yeah.] and things like that? So you learned from this, you think you learned about how scientists work and how they….
>
> John: How scientists work and how we can help scientists gather data.
>
> Megan: You thought that was neat? Had you ever done anything like that before?
>
> John: Not really. No.

John was the only one of the five participants who did not have a computer at home. Still, others perceived him to be an expert even while I observed him to be somewhat of a novice. In group settings, John asserted himself as an expert about scientific knowledge and how to do things. He did not hesitate to correct others when he thought they were wrong and often acted annoyed with his group members. In the computer lab, John almost always worked alone and never asked me for help, even though sometimes I think he could have used some. In the science classroom, John is one of four students who regularly participate in whole class discussions. He often raises his hand to offer answers and information about the topic under discussion.

Tommy

Tommy was selected to participate because he is the opposite of John in most respects. He is an average to poor student in all subjects and is highly social. He was described by Laura as an adept manipulator. This term was conveyed amicably as Laura likes Tommy and feels she has helped him have a more positive year in school than in fifth grade.

> Laura: As a student, he is very medium, C student, struggles, could be a C student. Has to work to be a C student, which is a great improvement from last year. Last year he spent his life in the principal's office. Totally, just had a miserable year last year, just totally dysfunctional. I don't know, he comes from—I don't know how in-depth you want—but he comes from living with

> just a father and a brother. Has a rough life. Dad is a sports person, and a kind of a little Napoleon. Very, dad's uneducated, is a, what does he do, he does garage doors I believe. A carpenter-type garage door type thing. Tommy is, he's one that you get on to him and it's always, "I'm sorry." He's a pretty smooth talker really. Maybe you could even say that he's a manipulator? But he's a neat kid. He's a neat manipulator as far as that goes.

Tommy is the kind of kid who loves the social life at school. He flirts with girls in his speech and mannerisms, touching them and joking around a lot. In a small group setting, he acts as a mediator when others have a hard time getting along. He is a peacemaker and reaches out in a friendly way to everyone I observed him interact with. I also observed actions that supported Laura's assessment that "he can also be an ornery little turkey that, you know, that can talk and be disruptive the whole time you're trying to do something too." He was 'caught' on videotape making sexually suggestive comments to the girls sitting next to him and turning off the microphone during parts of these conversations. He spent most of his time in the computer lab off task and trying to socialize with those around him, though he did get his report done and handed in on time. He did a lot of his work on his home computer. Of all the focus students, Tommy was the most enthusiastic participant. He was the first student in the class to come talk with me shortly after my arrival. He asked me what kind of car I drive as a conversation icebreaker. In my interview with him, he indicated he paid more attention during the Journey North project because he likes studying animals and was chosen to participate in my research. He strives to be accepted, feel important and be well-liked. As expected with his social personality, Tommy loved the opportunity to communicate via email with other students. Unfortunately, he never received a response from the other class, but still indicated using email was the best part of the project.

<u>The Classroom Teacher</u>

Laura volunteered to participate in the Journey North project to help me complete my research. We are family friends and she volunteered as a favor. As a result, she was new to Journey North but was also a novice in terms of using the Internet. She had been teaching for over 10 years and was currently involved in a prestigious professional development program sponsored by her state. Teachers must apply and be selected to participate. As part of the program, she attended workshops once a month throughout the school year and more frequently during the summer. After her first year in the program, she was selected to take the upcoming year off from the classroom and teach other teachers throughout a large region of her state.

Laura is an enthusiastic and energetic person who is well-liked by her students. Many parents requested her for their children, especially if older siblings had been in her class. She was teaching math and science this year, as well as reading to her homeroom. She described teaching math as her love and had been doing that for a number of years. This was her first year teaching science. During my interview with her, I asked about her science background.

> I am science certified, but I have to say I did not even know that I was science certified. Math was my love, so I sent my transcript in to see how far, what I really needed for middle school math. And they sent it back and said I was middle school science certified along with math. When I went back to school to get a teaching certification I had to take a couple of science classes. I had to take two five-hour science classes. And so, that really…and when I went to that first science class I hadn't had science in twenty years and it was just like, my goodness, I knew nothing. I mean, and so I have learned to enjoy science just from doing. Really. I mean, and I'm kind of the stereotype of growing up when I did because it was like, science was something I had to do but I didn't really enjoy it. And now it's really exciting.

She learned to really enjoy science while teaching it this year and collaborating with her teammates on lesson plans. She was pleased with how well her students liked the science curriculum they pulled together.

I would characterize Laura's teaching style as progressive. She was the academic leader in the classroom, directing activities and whole class discussions yet encouraging her students to work together. She stood at the front of the class when presenting and directing an activity, then spent the rest of the time circulating among students and interacting with them. She worked hard to create interesting lesson plans and did not rely solely on textbooks or one set of resources. Laura hosted a stock market club for students before school and took a group of eighth graders to Washington D.C. at the end of the school year with other teachers several years in a row. She seemed to enjoy her students and talked with many of them before and after school about themselves and their interests. During class she would often call both boys and girls endearing names like honey, dear and sweetheart. Students from previous years would stop by to say "hi" on occasion.

These positive personality traits helped create a motivating learning environment for many students. I observed that while students enjoyed science and learned many things, subject matter depth and critical thinking skills were lacking in her selection and presentation of activities as well as her leadership of class discussions during Journey North. Certainly, this was a result of her being new to science, Internet technology and Journey North. Many issues along these lines arose during my data collection and analysis that I had not anticipated during my conceptualization of the project. Her role as a novice provides many interesting issues to explore that I will address later in the findings.

This introduction and overview of the research setting, focus students and classroom teacher is intended to paint a general picture of the setting and individuals whose actions and interactions will be examined in light of the conceptual framework in the upcoming sections of this chapter. In conclusion, the following vignette further illustrates the classroom atmosphere by sampling one day in the classroom.

A Vignette

I arrive at Green Valley Middle School about 10 minutes before Laura's science class is to begin. While Laura is leading a discussion with her reading class, I enter her room quietly, set up my camera equipment and get ready to take notes. I am eager to see how today goes since the students will be able to read some responses from the class in Pennsylvania and work more on the mapping activity I pulled together. The communication and collaboration activities I wrote for Laura are providing a change from the daily worksheets and research the students have been doing for the past three weeks. While Laura and I are excited about all the collaboration pieces that are coming together, I want to see if they are also engaging and challenging for students.

When the bell rings at 9:25, the students collect their things and leave the room busily chatting. Laura comes over and we say hello before I ask, "Are you going to tell them about the challenge question responses? Is that what you said on the phone last night?"

"Should I? Or what do you think?" Laura asks.

"Well, I think they already have a lot to do. It might be too much."

"Probably, but it's just so exciting I hate to not tell them! It's like if I have a present for somebody, I have to show it to them, I can't save this stuff!" Laura is excited that a few of the focus students' responses to the Journey North challenge question are posted on this week's oriole update. I thought it was pretty cool myself.

Laura's science students stream in as noisily as the last group left. Most students take their seats immediately. Kurt enters with a paper airplane and begins flying it around the room, annoying a few classmates. Josh and Tommy laugh and give each other high fives. Amid notebooks slamming down on desks and lots of loud chatter, Laura walks to the front of the classroom at 9:30 and says, "Okay guys, I need your attention. Voices off." Tommy and Josh saunter to their seats and sit down.

"Okay, guys, we have lots that we're going to do today. Settle down. First, when you get to the lab, check your email. I think you're going to find that most of you will have some sort of message from what we have been able to figure out. You need to finish your migrations so be sure to take your colored pencils, be sure to take everything! Got that John? I don't want you to forget your things again," she teases in front of the whole class.

From my seat on the side I interject, "And you'll find a message from the expert on email."

"Right, guys, one of the things you're gonna find, remember when you wrote the questions to ask the expert? Some of your questions were picked. So you're gonna hear the questions that were asked and you're gonna hear the expert's answers. Who knows the expert's name?"

From the back of the room a girl shouts, "Dr. David Aborn."

Laura replies, "Dr. David Aborn, that's right. So you're gonna get a response and I think you'll be shocked at some of the questions that were answered, it's really very interesting. Any questions? Okay, let's go."

The students collect their materials and leave the science classroom in small groups. Laura walks outside with the first group and I collect my equipment and follow the last group of students out. Tommy is in that last group and asks if I need help carrying anything. I decline, but chat with him about baseball season on the short walk to the main building and down the hall to the computer lab. Once we get in the room, Tommy sits by Sally and watches while she tries to log on to check her email.

"What do I type again?" Sally asks me.

"Here's where you type your screen name," I help.

"Oh, yeah." I watch as it takes a long time to load. Eventually I say, "Why don't you work on your map and try your email later."

"Okay." This time Sally gets to the Journey North website independently by scrolling down the menu bar that brings up where people have been previously. She has made a lot of progress navigating the computer over the past week even though she still seems tentative.

Meanwhile, John, Jenny and Hannah are working at their own computers quietly as they usually do. When Sally starts working on her map, Tommy moves to an open computer and tries to check his email, as he does first every day. When this computer is also slow, Tommy pulls a chair next to John who is typing vigorously.

"Did you already check your mail?" Tommy asks.

John nods yes without looking at Tommy as if he hopes he will go away.

"Did you get written back?" Tommy persists. John only shrugs. "So let me try it now, try mine." Tommy is most eager about the email aspect of this project and it is killing him that he's been in the lab for ten minutes and hasn't been able to find out if he finally has a message. John doesn't really want to share with Tommy so he gives him a certain look that communicates, "Would you wait, I'm not done checking my own mail yet." Tommy gets the message but doesn't leave. This may be the only computer in the room that is actually in the email program. Tommy waits patiently for a few moments, then says to John, "I seen you. You were in the back of the car. Did you see me?"

John shrugs with disinterest, then says, "What?" when his curiosity gets the best of him.

"You didn't have your haircut yet. On Saturday."

John gives Tommy a quizzical look but doesn't say anything. He looks back at his computer screen and so does Tommy. "Four messages! Dang! Why don't you check em?"

"I just now checked em," John replies with annoyance. While John waits for one to open, Tommy drums his fingers on his chair then jokes around with a girl sitting on his other side. After a minute, she slaps him halfheartedly on the shoulder and says, "Shut up!"

Tommy's attention turns back to John when John says to himself, "Hey, here we go, here we go." John and Tommy read the email message that all the students received from David Aborn. I walk by as John exclaims, "Hey that was mine!"

"Was that your question?" I ask.

"Yeah, right there!" John is excited that his question was one of three from the whole class that was chosen. I read it too and say, "That's a good question." Tommy chimes in, "Is that yours? Which one's yours here?" John points it out with pride.

I suggest that John let Tommy check his email. Unfortunately, the only message Tommy has is the same message from David Aborn that he read on John's email. But Tommy is happy to get the one message from the expert.

During the rest of this class period in the lab, the quiet murmur of students working on their mapping activity is periodically interrupted with louder words of excitement as students find their email messages. Laura and I circulate to help students understand latitude and longitude and how to plot the oriole sightings on their map. The students seem challenged by the activity and most are engaged in their work. A few, like Tommy, use their freedom in the computer lab to socialize quietly instead.

With five minutes left in the period, Laura interjects, "Okay, guys, it's time to pack up your stuff, shut down the computer and push in your chairs. Please line up at the door." I follow the students back to the science classroom where they arrive just before the bell rings. In the hustle and bustle of the class change, I leave quietly while Laura gets ready to teach her incoming math class.

That evening, I decide I don't need to call Laura since I assume the class will continue working on the mapping activity and review the related discussion questions. The next morning, though, Laura instructs the students to finish their mapping activity, view the challenge question responses I encouraged her to hold over, and work on their research paper if they have extra time. To my disappointment, the discussion questions are overlooked.

Overview of Chapter 4

To orient you to the upcoming findings, I will explain the organization of this chapter. In the first section I examine research questions related to the **science classroom**. I discuss the class environment and gender interactions in that setting. In the second section I address class environment and gender interactions in the **computer lab**. A dominant theme in both the science and computer lab environments is that boys are more often perceived as science and computer experts than girls by their peers and by themselves, both when they are and aren't more knowledgeable. The third and final section addresses the significance of being a **novice.** The fact that the students and the teacher were new to the Journey North project and relatively new to using computers and the Internet became the most important factor in student learning in this study.

Section 1: The Science Classroom

Data presented in this section are organized around themes and interesting stories that address research questions about the science classroom. I will present data through these stories and then conclude the section with summaries of how the research questions have been addressed. The following list of research questions will help orient you to the upcoming section. The first subsection entitled The Science Classroom Environment will begin to address:

- **How do classroom dynamics influence girls' and boys' participation?**
  - Teacher-student interactions
  - Student-student interactions

- **How does the science content under investigation influence girls' and boys' interest and participation?**

The second subsection entitled Gender and Participation in the Science Classroom will address:

- **What does the teacher say about gender differences in science?**
  - Does she observe any differences between groups of boys and girls in terms of participation, interest and learning?
  - What kinds of variations does she note?

- **How do students view science with regard to gender?**
  - Do students observe any differences between boys and girls in terms of participation, interest and learning in science?
  - Are course materials gender biased?
  - Is their teacher gender biased?

- **In what ways, if any, do the girls indicate that adolescence is a cultural initiation into femininity?**
  - In what ways do girls enact feminine stereotypes in the science classroom?
  - In what ways do they resist these stereotypes?

The Science Classroom Environment

Laura had 23 students in her 45-minute science class; similar to all her classes. The desks were arranged in groups of four or five around the room with her desk in the back corner of the room. Laura assigned student seats to create "cooperative learning groups." These groups included students of varying performance levels. Toward the end of the semester, Laura let the students choose their own seats.

Laura generally began class with a presentation that included review, information and instructions for the day's activities. Sometimes students completed a reflection writing task for the first 5 minutes of class. Then students could work alone or move to work with friends on the activity. The classroom was generally noisy when students worked together or when the class next door was free to interact. When they had a whole class discussion, Laura led the question and answer session. Occasionally students questioned each other or held a short discussion about the topic in front of the whole class. Generally, it was teacher directed. Science class was also frequently interrupted with special programs, testing, field trips and substitute teachers, especially since it was the last period of the day. To eliminate some of these interruptions during my research, Laura coordinated with her teammates to move science to third period temporarily.

Laura described science as most of her students' favorite subject. While Laura was new to teaching science, she was very pleased with what she had accomplished in teaching science this year.

> Megan: So how would you assess this year, your first year?
>
> Laura: In science? We probably, and I say "we" because the three teachers, you know we collaborated literally every day we would spend at least 45 minutes on science, I mean doing, figuring out different lessons and innovative things to do, and I would say if you ask our kids probably science is one of their favorite classes. And it was because we did away with the book, it's all pretty hands-on, and a lot of it they were aware that we were learning as they were learning, and so I was pretty pleased with it. There's a lot that I would do differently, I mean there's a lot more depth and I have learned so much. But, yeah, but it's a lot of work getting it set up to make it intriguing. It really is.

<u>Hands-on Science is Fun!</u>

The five focus students' comments about science class corroborated Laura's assessment that science was a popular subject.

Table 4.1: Student Interest in Science

Jenny	I like science. I like doing the experiments and stuff.
Sally	I've always liked science and since I moved here I've liked it even more because we do a lot of fun projects and everything, so I really like it.
Hannah	It's fun, because it's like one of the easiest things to do, because you get to do experiments. We made Play-Dough and goo, and it's fun!
Tommy	I liked studying birds for a long time. We've done that in fifth grade, but not that much. Like we just studied about the owl and you have to do this little thing where you bring in owl stuff that they puked up, and you have to pick out all the bones from like the rats and stuff. That was cool.
John	I like science, and I like the study of animals and the way things work. … One of the things we did was some experiments with solids. I've learned that Silly Putty is a solid and a liquid at the exact same time. Because you can fold it, punch it, and it'll do that. And like, slime is also that way. Because if you hit it real hard it'll bounce you back. But if you slowly push in, you'll be able to go straight through.

The fact that science units were organized around hands-on activities really stuck out in students' minds. In one unit, students worked in groups to design and build bridges with toothpicks. They used real-time information such as the cost of building materials in the project. Sally indicated that this was her favorite science activity because, "it was really fun to build and see how much things cost these days, and just to write checks and everything. It was really fun." Jenny liked the simple machines unit in which they designed and built can pressers to crush cans and juice boxes. When I asked her what she liked about that, she replied, "That we got to crush the can." None of the focus students could think of anything they disliked about science this year.

The science curriculum in this class reflects a progressive, science/ technology/society approach more than a traditional, abstract science model. As suggested in the literature review, this proved to be highly engaging for a variety of students in this classroom. Additionally, students were often allowed to work with a friend or in small groups to complete science activities and projects. In this way, there was ample opportunity for communication and collaboration among students in the science classroom.

Journey North

The Journey North project complemented the progressive science curriculum approach already at work in Laura's class. In addition to the Journey North activities conducted on the computer, students also engaged in a few hands-on activities related to the topic under study. With some direction from me, Laura decided her class would follow the migration of the oriole during the Journey North project. This migration was selected because the birds would migrate through the local area during the project and students would have the opportunity to ask questions of the oriole expert in May. Laura also had her students follow the leafing out of local trees and complete two of the suggested activities concerning how animals know how and when to migrate. The class also worked on an activity that showed them how to construct their own oriole feeder to put in their backyards.

Many students enjoyed studying the oriole because they learned to spot them in their community. For example, Tommy indicated in his interview that "I like studying orioles because when I'm down at the lake fishing with my dad we see a lot of them, and it's a fun project to learn when you're young like in sixth grade." At the end of the project, Laura asked her students about their participation outside of class. Fourteen indicated they had seen orioles and nine put up oriole feeders at home.

In this classroom, hands-on science activities presented before and during the Journey North project were highly engaging and encouraged a high level of interest and participation among students. These data relate most directly to the research question regarding how the science content under investigation in this class influenced student participation and interest. It appeared that the active, hands-on method of investigating science content was most significant in determining student interest in science, not particular topics. This section also begins to address the other research question regarding how classroom dynamics influence student participation and interest. Cooperative learning groups and time to work with peers on science projects created a collaborative and social classroom atmosphere. Data related to this research question will be more fully explored in the next section on gender differences in the science classroom. The next section will also address the research questions regarding what the teacher and students say about gender differences in science and the ways girls enact and resist feminine stereotypes in science.

Gender and Participation in the Science Classroom

On the surface, it was difficult as an observer to spot gender differences initially in this science classroom as suggested in the conceptual framework. My understanding of the effect gender had on student participation became evident only after I thoroughly reviewed the data. Students had a hard time acknowledging gender differences in the interviews, and when they did indicate differences, they often attributed them to individual or personality differences rather than to permanent differences between boys and girls. Laura was able to quickly assert an opinion on gender differences in the interview, but at the same time did not notice some of the differences I observed. Gender differences are complex and elusive at times. However, data analysis revealed some striking differences.

Boys as Experts

A main theme that emerged from the data was that boys are more often perceived as experts in scientific knowledge and procedures than girls in this science classroom by themselves and by their peers. The term "expert" refers to who is regarded as having the most knowledge in this classroom by all the members of the class (the students, the teacher and myself). The notion that boys are viewed as experts most often became evident upon review of my observations in the science classroom and in my interview with Laura. For example, I asked Laura about any gender differences she observed in her science class.

> In my science class, in my particular class, and there's like three boys that, I mean the kids kind of look to them as like, well, and there's one in particular which is John and if you need an answer, you know John is probably going to have it. And there's only about one girl that really I can say enters in all the time. And the rest of [the girls], if you would call on them they will have an opinion, but do they put their hand up, do they volunteer information? No. They really don't at all.

She indicated that the girls who are especially strong students in language arts aren't as assertive in science class. She sees her students identifying themselves as "a math-science person" or a language person and that in her group of students this year, "the boys seem to be stronger in science, and some of the girls that are very, very strong in language arts don't participate that much." Additionally, Laura observed that the boys are the ones who "want to raise their hand, want to be noticed" in science.

Several of my observations in the science classroom corroborated this statement. A subtle yet interesting observation was of the seating arrangement the students self-selected. At the end of the semester, Laura let the students choose their own seats. Boys occupied the seats in the table groups in front, center of the classroom while the girls moved to the back and side table groups. Only one girl occupied a seat among the boys in the front, and she was there because she refused to move (that had already been her seat). Laura also indicated this girl had trouble socially and would likely have been left out if she tried to join a girl table group. Only one boy occupied a seat among a girl group and Kurt, the one who Sally, Hannah, and Laura said they had trouble working with, moved his desk to sit alone.

Another observation of how the boys in this classroom were more active science participants occurred early in the project when Laura was presenting information on how to write a mini-research paper, the main assignment for the Journey North project. Laura presented a model paper on the bald eagle and asked the class questions about how it related or did not relate to the oriole that they would be researching. As reported by Laura, three boys and one girl were the primary contributers to any questions Laura asked of the class. They volunteered repeatedly to respond to her questions and were eager to elaborate on the topic. John was one of these students. Here is one example of an exchange in which John responds to a question with more general knowledge and science vocabulary than the other students who volunteered.

> Laura: Do you think the eagle food chain and the oriole food chain will be similar?
>
> Hannah: I don't think so because the eagle is like a different bird.
>
> Laura: Okay.
>
> Daniel: It eats like a seal and a deer and a duck and an oriole eats only… (too quiet to hear).

John: One thing is that the eagle is a bird of prey, so it'll like hunt things, and the oriole isn't really that. It'll eat like an insect or two but it really isn't a bird of prey.

Laura: Bird of prey, okay, good observations guys.

As Laura was aware of this participation discrepancy, she often made efforts to pay attention to and call on girls whom she thought would have valuable information to contribute to the class discussion. Jenny was one of these girls. Jenny's grandmother was a birdwatcher and one day Jenny brought an oriole's nest to school that her grandmother had saved. Jenny showed the nest to Laura privately at the end of science class and told Laura about programs on birds she had seen on the Discovery Channel. Laura tried to single out Jenny as an "expert" in front of the whole class several times. When talking about what the students could write in an email exchange with a class in Pennsylvania, Laura provided Jenny an opportunity to share her knowledge with the class.

Laura: ... Let's look over here about the project. What is something you could share about the project?

No responses.

Laura: Jenny, what would you tell them? You're one that's gotten into this and found, what could you tell them about your bird nest?

Jenny: [...] (Too quiet to hear).

Laura: Right that you actually found one, that your grandmother had one. Guys, all this stuff is information that will be of interest to them.

In another example when students were finishing their research papers, Laura called on Jenny again and presented her as an "expert".

Laura: Some of you were having trouble with the oriole reproduction. I will tell you that the latest [oriole report] which we're going to be looking at tomorrow, has quite a bit on it. But also, Jenny gave us a website and where she found her information on reproduction, so let me write it up for you if you want to copy it down. Also, encyclopedias have quite a bit on that too. Don't forget your report is due on Wednesday, I already have a few that look very nice. ...Okay, if you will look at this address up here... (www.birds.cornell.edu/BOW/BALORI) this is where you got most of the information, right?

Jenny: Some of it.

Laura: Some of it okay. Be sure these are in capital letters. ...

In keeping with her shy personality, Jenny did not take the opportunity presented by the teacher to elaborate on her knowledge of the website or oriole reproduction in front of the class. Her response stands in stark contrast to John's earlier discussion of the difference between an oriole and a bald eagle. He exhibited confidence in his knowledge and role as an expert in the science classroom while Jenny did not. This is one example that reflects Laura's observation that boys are the ones who "want to raise their hand, want to be *noticed*" in science (emphasis mine). To relate this section back to the research questions, Jenny's shyness and lack of assertiveness is one example of the enactment of a female stereotype in science class. Her actions indicated that she did not feel comfortable playing the role of an expert in this setting. This section also presents an example of how Laura made efforts to avoid gender bias in her classroom.

Boys as experts in a small group discussion. Several significant gender differences also became apparent upon review of a video tape of the five focus students working in a small discussion group in the science classroom. The interactions in this example address the research question regarding how student interactions influence boys' and girls' participation as well as how girls enact feminine stereotypes in the science classroom. In this discussion group, students were instructed to discuss and come to consensus on a number of questions related to a Journey North activity they had completed in the computer lab. In this first example, I will present how John and Tommy exert themselves as experts, and are accepted as experts, more often than the girls in the group.

John was well-established as a scientific expert in the classroom. He seemed to gloat in this role and exhibited an attitude that he was intellectually superior to those in his group by acting annoyed with them and offering answers to each question. Tommy was not considered a scientific expert by his peers or teacher. In fact, he was a poor student yet highly sociable. The first two minutes of the group's interaction begins to illustrate how both John and Tommy assert themselves as experts in scientific and other matters. Here is my transcription and commentary.

> In the small group with the five students, Sally is the recorder. They have begun when the camera gets set.
>
> Tommy: (to Sally) sighted, sighted, that's not how to spell sighted, but that's alright.
>
> Sally: (She erases it) How do you spell it?
>
> Tommy: (Looking over her shoulder) S-i-t-t-...d.
>
> Hannah to John: What did you get on your test yesterday?
>
> John: What test?
>
> Laura comes over suddenly: Are you guys okay back here? Is everybody adding their answers? (No response.)
>
> John: It's Tommy's turn now.
>
> Sally: Okay, what is the kind of people, what kind of peo-, what kinds of people-

John: No, Tommy has to answer that! (Sally passes paper to Tommy).

Tommy: (Begins reading the question) What kinds of people do you think participate in Journey North who aren't students?

John: Hey, Tommy. We do this one, you answer it. We all answer it.

Hannah: You spelled sighted wrong.

Tommy: What is it, one t?

Hannah: S-i-g-h-t-e-d.

Sally, Tommy: Oh well.

John: What do you think, Tommy?

Tommy: I thought the same answer but, um... mumbling. What now, you said we're on this, what -

John: (exasperated) Yes! Everybody has to put in their input, or say. Everybody has to say!

Tommy begins to offer an answer about why latitude and longitude are important, but can't articulate his point so John eventually blurts out "Yeah, to record data". Tommy writes it down. Then Tommy passes the paper on to Hannah, but John argues that Sally is supposed to write it down. Hannah is irritated and states her understanding of how the group is supposed to operate. Tensions are high, no one but John seems to know what to do. Jenny is silent the whole time. I finally interject and give them some instructions to go around and talk about each question first, then once they agree, have Sally write it down. After a moment of silence, Sally proceeds by asking the next question.

In this excerpt, several things are going on. One, John is the only one who knew how the group was supposed to operate based on the instructions I heard Laura give. He repeatedly asserted his knowledge and became irritated with the others for not knowing what to do and not listening to him. John directs the others in his group without reservation. Hannah stands up to him when she believes she knows what to do, but is overruled when I step in to reiterate the instructions that support John's position, bolstering his role as expert.

Two, Tommy asserts himself as someone with valuable knowledge as well. He immediately corrects Sally's spelling and later attempts to respond to the question about latitude and longitude they were trying to discuss. However, he can't articulate his response because he doesn't seem to have a clear idea about the question, he just wants to try and participate. Tommy may also be trying to ease the tension created by John's exasperation toward the group confusion. In this and examples to come, Tommy often acts as a peacemaker by offering comments or humor to relieve tense situations.

Three, Sally accepts Tommy as a spelling expert (when he isn't) and rejects Hannah as one (when she is). Tommy and Hannah both correct Sally's spelling. Sally erases her word and writes down what Tommy says, but ignores Hannah's comment that it is still wrong. This could be because Sally and Tommy have been flirting with each other in the computer lab over the past two weeks and Sally wants to please Tommy. It could also be that when Hannah corrects Sally, she is starting to get embarrassed by being corrected and wants to downplay her lack of knowledge by moving on. But then there are two other exchanges about spelling in which Sally responds very differently to Hannah than to Tommy and John.

Sally: Who might participate in Journey North who aren't students?

John: Teachers.

Tommy: Bird watchers.

Jenny: People who study birds.

John: Scientists, teachers, birdwatchers…

Tommy to Sally: t-i- (spelling correction)

Sally: I knew that.

Tommy: Yeah, sure you did.

After a moment, Sally reads the next question.

Sally: Okay. What kinds of problems could come from so many people posting their local sightings?

Tommy: That they don't know what the latitude and longitude is.

John: Overload database

Tommy: They put too much stuff in it.

(Sally writes something down and Tommy reads the next question.)

Tommy: How might scientists handle these problems?

John: Tag orioles. You know, so that they say I saw oriole number 35.

Tommy: Only at the most write like two paragraphs. (referring to his comment that some people write too much about their local observations)

Sally shrugs her shoulders and hands. Jenny shrugs too.

Sally: I don't know.

Jenny says something inaudible.

Sally says and writes: Tag. How do you spell that?

John: T-a-g, tag. Tag the orioles.

Hannah to Sally: You spelled base wrong. (referring to database)

Sally: No, like the base of a tree, it's b-a-s-e (Hannah has no comment.)

Sally: What else?

John: Tag orioles.

Jenny: Tag the orioles.

Hannah: You spelled it like bass.

Sally: bass and base, it's just (shrugs her hands) -

Sally shrugs as if to communicate "I don't really know and I feel a bit uncomfortable and irritated now." They all sit there in silence for a while, not looking at each other.

Tommy: We need to put our names on this (breaking the discomfort of silence and tension). Tommy covers Sally's eyes playfully. They all just sit there, John is drumming table, Jenny and Tommy yawn.

In this excerpt, Sally argues with Hannah that her spelling of database is correct while moments earlier she did not act offended when Tommy corrected her. She appears to accept spelling suggestions from Tommy and John (both solicited and unsolicited) but not from Hannah. In this way, Sally is willing to defer to the boys in the group as experts, but not the girl.

In another exchange during this discussion, John continues to assert himself as a group leader and scientific expert.

Hannah: (reads next question) Here are some reports that were submitted during a previous Journey North season. Read them and decide whether you would believe their accuracy or not. Why would you accept or deny each report? (Quiet for a minute)

John: Read em!

Hannah: A kindergartner in Minnesota reported a sighting of 500 monarch butterflies in Minnesota in February. The kindergarten teacher said her students were just learning to identify monarchs at the time.

John: Okay, that's like false.

Hannah: Yeah, how would the kids know it was five hundred?

Jenny: Cause they can't count to five hundred.

John: Yeah.

> Tommy: Hey, I could count to five hundred when I was a kid.
>
> John: A kindergartner?
>
> Sally: … can't as it is!
>
> Tommy to Sally: You can't right now!
>
> Sally: I know!
>
> Tommy: One, two, three…
>
> John: Too young of age and um, how could you count that much, really, how could any person…
>
> Sally: Maybe they saw the same one.
>
> John: Yeah. And how could they, oh they could have been mimic butterflies. There's a special type of butterfly that mimics the monarch.
>
> Sally: Oh.
>
> John: and… (trails off).

John thinks about offering more information he has about the mimicking butterfly, but lets it drop. Perhaps it was the coolly disinterested "Oh" he heard from Sally. While all five group members said something in response to this question, John's comments punctuate everyone else's comments. He is the most avid participant, another way in which he presents himself as an eager expert.

As the discussion continues, John wins another argument, this time about the math concept of even and odd. Sally tries to stand up to John when she believes she is right. However, she is not right, and she eventually gives up when Tommy makes a joke out of the conflict.

> Hannah: Okay so, how would students know if there were exactly 500 hundred monarch butterflies, how would they be able to count all of them
>
> John: How would they be able to count.

Jenny: It may not even be an even number.

Sally: Well, it's not an even number.

John: It *is* an even number. It's even.

Sally: Five isn't an even number.

John: Five hundred.

Sally: I know.

John: Five hundred is even.

Sally: If you had twenty-five, oh you could do that. Okay, if you had thirteen kids you couldn't split it evenly.

Tommy: Yeah, you can. Six and a half. Cut one in half.

Sally: Laughs, cut a butterfly in half, oh yeah, that's nice.

John makes an arm movement to show splitting in half

While Sally tries to participate in the discussion, she is repeatedly corrected, earlier for spelling errors and now for math errors. Tommy even teased her about not being able to count to 500 and she went along with it, making fun of herself by saying, "I know!" As the discussion continues, Sally is almost right about something, but quickly accepts John's rebuke.

Hannah: Okay, On April 9, a monarch was reported in New Jersey. Other monarchs reported at the time were in Georgia, Alabama, Kansas and Missouri. The New Jersey report was sent by a naturalist who tags hundreds of monarchs each fall.

Jenny: Tags?

Sally: Yeah, puts little tags on their legs.

John: No, on their wings.

Sally: On their wings, on their beaks, keep em shut, ha ha.

Sally is thinking about birds that can be banded on the legs for tracking purposes. However, the question was about tagging monarch butterflies. Monarchs would be tagged on their wings, as John says. So, while John was correct about the monarchs, Sally could have insisted that birds are sometimes banded on the leg and they could have figured out the confusion. Instead, Sally immediately defers to John and makes a joke about tagging beaks, perhaps to draw attention away from her "mistake." This shows she is still thinking about birds and therefore capitulates when she is not wrong. Sally's lack of confidence is indicative of how some girls enact feminine stereotypes in science that undermine their confident participation. Sally illustrated this by deferring to boys and belittling herself in this section.

Boys as experts, even when they're not. In this next section, I will continue to present data that show how the boys in this group are more willing to view themselves as experts in science class than the girls. As presented in the previous section, John is viewed as a scientific expert by himself, his peers, his teacher and myself. Tommy is interesting to examine in comparison with John because he is not viewed as an expert in science, at least not by myself or Laura. However, like John, Tommy tried to assert himself as an expert more often than the girls in his group.

In the following excerpt from the same small group discussion, Tommy is now the recorder and participates even though his answers indicate he does not know what he is talking about. In fact, none of the students have their maps in front of them on which they plotted data about the orioles' migration across the country or when trees leafed-out across the country. Therefore, they are trying to answer questions about these data without being able to see them. Unable to contain myself, I eventually break into the group discussion and help them get on track.

> Tommy: Okay. (Yawns.) Finally, I get my spot. What patterns do you notice in the data? (Puts head down)
>
> John: That sometimes there's, like, a lot of orioles in one spot.
>
> Sally: giggles
>
> Tommy: All right so… (points to Jenny)
>
> Jenny: Or maybe the migration patterns …. (Her response fades out because she speaks too quietly for the microphone to record).
>
> Sally: (shrugs and giggles) I don't know.
>
> Tommy: So I'll put migration patterns, that's where they're going.
>
> Megan: Do you guys have your maps?
>
> Students: No.

Tommy "calls" on Jenny to pull her into the conversation when he noticed she had something to say and couldn't think of a response of his own. He writes down "migration patterns" as their response and adds, "that's where they're going" with authority as if the answer makes perfect sense. Without any data to view, it is impossible for the students to offer any more specific responses than stating the obvious, that the patterns in the data would show the migration pattern of the species. With their maps, however, they could have discussed the dates the orioles migrated to an area, how long they stayed in one place, or how the orioles' migration related to the dates the trees leafed-out across the country. They continue to try to answer questions about data they do not have in front of them.

> Tommy: Okay, Johnny. (He passes the paper onto John for him to read and record the next question.)

John: Were there any like any 'outliers' or strange data that didn't make sense to you? If so, what were some possible explanations for these?

Tommy: Yeah, there was a lot.

Sally: Shrugs.

John: Strange data (reiterating the question). (No response from anyone.) Maybe nothing is true.

Tommy: snores. Um, no. (Takes kleenex box and pretends to knock Sally in the head with it). Give me five. (Sound effect).

Again, Tommy quickly adds, "Yeah, there was a lot" when it is clear he has no idea what he is talking about. He doesn't have his map so he is not attending to dates he plotted on his map. Perhaps he is responding to the part of the question about any data "that didn't make sense to you" because he was confused about the purpose of the activity. Then John redirects Tommy's response by restating, "Strange data." Tommy then changes his answer to "Um, no." Now he doesn't remember anything strange. Tommy then begins goof around and no one else has anything to offer. Tommy continues to participate and act as if he knows what he is talking about in front of his teammates when he doesn't. No one but John questions his responses. When I interject into the group to get them going, Tommy continues to participate without reservation when he is contradicted by John and then myself.

Megan: You guys didn't see any weird sightings of orioles in New Jersey in February or anything like that?

Tommy: No.

John: Well yeah, there was one. There was a Canada one in February. That was weird.

Megan: Yeah, there were some. There were some leaf-out reports, I don't know if you did leaf- out but, there were some leaf-outs way up north in February and March.

Tommy: Yeah, I did that.

Megan: So that would be weird, right?

Tommy, John: Yeah.

Tommy to John: So why don't you put leaf-out in February and March.

John: Okay. (writes it down)

Tommy continues to engage in the discussion with confidence and even directs John on what to write down. He has established himself as a group leader through active participation in the discussion, calling on and directing others, and socializing when they are stalling or to diffuse conflict. The other group members, even John, respond positively to him. While Tommy is not as knowledgeable about the scientific content as John, he is not timid about faking it or asserting his ideas when they are good. In this final example, Tommy believes he can generate an idea even after John states it is a difficult question.

Jenny: Reads question, inaudible to microphone. (The question was "How would you go about finding out whether to believe the strange data or not?")

John: Hmm. That's a toughy one. And I'm not being sarcastic either. (silence)

Tommy: um… let me see it Jenny.

John: See how long the leaves have been there?

Hannah: Do research.

Tommy: (reading the question) How would you go about whether the … Go to the, uh, the oriole and go to weather thing, the set up data. On the website, Is that it? Yeah, uh I think that's it. Go to weather.

Megan: Oh, look at the weather reports from the area?

Tommy: nods yes.

Megan: That's a good idea.

Hannah: You could do research to explore different possibilities.

(While Jenny writes these answers down, Sally and Tommy have a side conversation, John leafs through magazine, Hannah stares at Jenny)

While not clearly articulated, Tommy offers a response this time that indicates he is actively engaged in the discussion and making connections between the material they encountered on the Journey North website and how it could now be useful. These data support the notion that boys believe science is an area in which they can confidently participate. Tommy's attitude stands in contrast to Sally's less confident approach to asserting her ideas in this small group.

Girls Participate Less and Are More Often Ignored Than the Boys

Now I will continue this examination of participation differences in light of the research question about the ways girls enact and resist feminine stereotypes in science class and how student interactions influence participation. Throughout this entire small group discussion, I counted on my transcript how many times each group member spoke to illustrate participation differences. Reading a question, asking questions and offering answers were included in this count as well as comments such as "I don't know" or "Yeah." The numbers illustrate how much more often John and Tommy's voices were heard overall.

Table 4.2: Small Group Participation

Group Member	Number of Comments
John	58
Tommy	38

Sally	24
Hannah	22
Jenny	18
Megan	14

As the previous section on boys as experts began to show, the character of these comments differed between participants. John was the most avid participant and his ideas were generally focused on the task at hand and correct. Tommy also participated more than the girls, but some of his comments were of an off-task social nature and his on-task ideas were not always accurate. In contrast, Jenny spoke very little but often had good ideas to offer during the small group discussion. Jenny had worked hard throughout the project and turned in her oriole report days in advance. Jenny apparently discussed the project with her grandmother, the birdwatcher, since she brought in an oriole nest. Based on Laura's assessment of Jenny's general performance in science, her work on the project and her ideas during the group discussion, I would rate her as second to John as a scientific 'expert' out of the five focus students. However, during the small group discussion, Jenny's efforts to participate were often ignored. Here is one example; a continuation of an excerpt we've already heard.

> Megan: You guys didn't see any weird, like, sightings of orioles in New Jersey in February or anything like that?
>
> Tommy: No.
>
> John: Well yeah, there was one. There was like one in Canada in February. That was weird.
>
> Megan: Yeah, there were some, there were some leaf-out reports, I don't know if you did leaf- out but, there were some leaf-outs way up north in February and March.

Tommy: Yeah, I did that.

Megan: So that would be weird, right?

Tommy, John: Yeah.

Tommy to John: So why don't you put leaf-out in February and March,

John: Okay. (writes it down)

Jenny: … (comment is undetected by the microphone, yet the group members could hear her)

Megan: Right, so Jenny was just gonna say what could be an explanation for that?

Tommy: mumbles.

Jenny: inaudible

Megan: Did you guys hear what Jenny said?

No response. Silence for a while.

John: Alright. (hands the paper to Jenny)

Megan to John: Did you write down what Jenny said? (I read it and he had written it down – "maby (sic) a bit more sun and water".) Okay, any other ideas?

John: (Nods his head no.) That would probably be the best, maybe it was just some weird case where a tree just thought it was warm enough to leaf out.

In this next example, Jenny attempts to enter the misguided conversation about whether they would believe a kindergartner's report of seeing 500 monarch butterflies in Minnesota in February. John and Sally have their disagreement about whether 500 is an even number after Jenny's comment. Jenny is interrupted, her point gets lost and she never really becomes a legitimate participant in the discussion.

Hannah: Okay so, how would students know if there were exactly 500 hundred butterflies, how would they be able to count all of them

John: How would they be able to count-

Jenny: It may not even be an even number.

Sally: Well, it's not an even number.

Jenny: Well-

John: It is an even number. It's even.

Sally: Five isn't an even number.

John: Five hundred.

Sally: I know.

John: Five hundred is even.

Sally: If you had twenty-five, oh you could do that. Okay, if you had thirteen kids you couldn't split it evenly.

Tommy: Yeah, you could. Six and a half. Cut one in half.

Sally: (Laughs) Cut a butterfly in half, oh yeah, that's nice.

John: makes an arm movement to show splitting in half

Tommy: They do that.

Jenny: Could have been like five hundred and one.

John: (Looking at a magazine) Mars could end up being like our second planet.

Sally: I don't even know what a monarch looks like. Oh, that was a pretty bug (referring to magazine picture)

John: Beetles.

Sally: They're shiny.

John: They're jewels, actually.

Tommy: Those are awesome.

Like the others, Jenny is caught up in the high number of butterflies reported but I think she meant that 500 couldn't be an exact count. Jenny's point is never understood by the others even when she tries to clarify it after the argument. Instead of acknowledging her, John and Sally attempt to smooth over the conflict by discussing an unrelated picture in a magazine.

On two other occasions, though, Jenny offers an idea to which John immediately responds, "Yeah." Here is one of them. As before, the students are to decide whether they believe the accuracy of the reported event.

> Hannah: A student in College Station, Texas, reported seeing his first monarch on May 20. Many monarchs were reported in Texas in March and April.
>
> Tommy: snores.
>
> Jenny: He doesn't get out that much.
>
> John: Yeah, there you go.
>
> Sally: (Laughs)
>
> Tommy: I'd think it's true, because you know, that's what you have to do in college. That's what Ms. Mistler-Jackson's doing in college.
>
> John: Could have been a late one.

Jenny's quick, clever response gets a laugh from Sally and recognition from John. However, no one takes her comment any further. Throughout the group exchange, Jenny seems to be ignored because the others mistakenly do not view her as one with much to offer. Her quiet voice undermines her ability to portray herself as an expert. And by volunteering so infrequently, Jenny does not seem to view herself as an expert who is worthy of greater participation. As a result, while Jenny has the potential to be considered an "expert," neither she nor her peers view her as one.

While Jenny is enacting a feminine stereotype of a non-assertive girl in science, it is both her interactions and others' responses to her demeanor that result in her limited participation in this small group discussion.

Sally Says I Don't Know More Than the Others

While Sally participated more frequently in the small group discussion than Jenny, few of her comments were ideas related to the discussion. Instead, four of her twenty-four comments were "I don't know." Several others times she shrugged or giggled, communicating "I don't know" in other ways. Many of her other comments were reading the question as the recorder and asking questions such as "How do you spell that?" and "What else?" Her other interactions have been reviewed before in which she argues with Hannah about the spelling of database, and with John about how monarchs are tagged and 500 being an odd number. Therefore, Sally did not contribute much to the scientific aspects of the small group discussion. She presented herself as lacking confidence through her interactions and gestures during the group work and was therefore also not viewed by the others as one with meaningful ideas to offer.

Hannah is the Exception

Hannah's interactions are a bit different than Jenny's and Sally's during this small group discussion. While she does not volunteer to participate as often as John and Tommy, her comments are more substantial when she does participate than the other two girls. By substantial, I mean that her comments are more on task than Sally's and more assertive and confident than Jenny's. In one exchange, Hannah holds her own with John in discussing whether they would accept or deny the accuracy of a reported observation. She does not immediately back down from her position but instead actively defends it, never deferring to John as the expert.

> Hannah: Okay, On April 9, a monarch was reported in New Jersey. Other monarchs reported at the time were in Georgia, Alabama, Kansas and Missouri. The New Jersey report was sent by a naturalist who tags hundreds of monarchs each fall... .
>
> John: Well it could have been, it could have been an early bird, it could have been an early one.
>
> Hannah: Cause the other ones were reported in Missouri, Kansas, Alabama and Georgia.
>
> John: Well there is, well there is, you know, places where, there is at times, you know, it could have been the first monarch travel up.
>
> Hannah: Georgia and Alabama are close to each other, like right side by side, and Missouri and Kansas are right side by side.
>
> John: Yeah but Georgia's in like-
>
> Jenny: Yeah Georgia's right next to Alabama.
>
> Hannah: And New Jersey is, and these are ... north.
>
> John: See here's how it is on the map. See, here's like Missouri and Kansas-
>
> Hannah: They're still close.
>
> Sally: Yeah.
>
> John: They might be touching but that's hardly like-
>
> Jenny: Yeah here's the state line and-
>
> John: Yeah New Jersey, I understand New Jersey's way up-
>
> Hannah: New Jersey's way up north like by Maine.
>
> John: Yeah but it could have been like the first monarch.
>
> Megan: So you say you wouldn't believe it and you say you would believe it.
>
> John: Yeah.

Hannah: I wouldn't believe it, I mean it's too far out.

John: But like that oriole in Canada, it could have been like the first timer.

Megan: Does it matter to you who saw it?

Hannah: A naturalist.

John: Yeah, a naturalist who tags em.

Megan: Does that make them more credible or you still won't believe them because it's too far out.

Hannah: It seems too far out for me.

Sally: Yeah, I agree.

Megan: Okay, then say you disagree. You guys have two different opinions.

This was the most "heated" argument during the whole discussion because John and Hannah both persisted in defending their position. They were both knowledgeable about geography and used plausible arguments to support their position on whether or not they would believe the report submitted by a naturalist. Tommy, Jenny and Sally all entered in the discussion at various times, indicating they were listening to the discussion between Hannah and John. Sally said she agreed with Hannah a couple of times but did not expand on her reasoning. Tommy indicated he thought they both had good points, but didn't know what he thought. Jenny also said she wasn't sure what to think. The disagreement allowed all the group members the opportunity to participate and have their opinion validated when I entered in the discussion to help them handle the discrepancy.

So, while this example indicates an exception to the pattern that the girls in the group deferred to the boys as experts, Hannah did not participate enough throughout the entire small group discussion to eliminate the pattern. She was the recorder during this part of the discussion and was therefore forced to read the question and remain engaged in the discussion so she could record her group's response. Perhaps she would not have been so involved if someone else had been the recorder at this time. As a result of her lack of participation, the two boys in the group asserted themselves more regularly and with more confidence throughout this interaction than the girls. Again, these data support the notion that boys and girls perceive boys to be greater potential experts in science class, which in turn, limits girls' participation.

Gender Role Models

During my observations in the science classroom, the students were exposed to both traditional and non-traditional science role models. Their teacher, Laura, was a female yet was new to teaching science. Several times she indicated she was learning along with them and consistently portrayed an enthusiastic attitude toward learning about science. I was a female researcher in their science classroom and probably came across as more of an expert in science and computer technology than Laura, though I never asked them about this. One day, the whole team came together to hear a female meteorologist from a local television station give a presentation about severe weather. After her presentation, students were given time to ask her questions. Of note was an exchange when she shared a bit about her science background. Here is the related excerpt from my journal entry.

> One boy said he wants to be a "weather watcher" and wanted to know what he had to do to become one, like college classes. She said he didn't have to take college classes to become one now, there is a weather watcher program he can do. But if he wants to pursue it long term, she said he would want to take lots

> of earth science classes, meteorology and physics and not be afraid of math. "Love math," she said. She said that she, as a high school senior, had a poor science background. For mitosis, she drew a picture of her foot with an arrow pointing to her toes. She said she turned it around in college though, because she decided she really liked science. At the end of her talk, she told the kids they could email her with any further questions they have and wrote her email address on the board. If the students are just learning about email, this may have sparked their interest more than before they were setting up their own accounts and learning about using it.

As a role model, this meteorologist conveyed some interesting messages. One was that she now loves science and is successful in pursuing it as a career. At the same time, she conveyed that she was not initially successful, interested or talented in science in high school. So, she normalized both her experiences as a girl alienated from science in K-12 education and as a woman who was able to overcome this poor start.

The students were also exposed to the oriole expert in the Journey North project who was a male. While the Journey North project hosted both male and female scientific experts for each species the project covered, this class only interacted with David Aborn. In one class activity, the students worked in groups to create a skit about some topic from Journey North. In one skit, a boy (who was one of the three regular science participants like John) played David Aborn while Hannah played the interviewer. In another skit, John presented all the information the group learned about how scientists recently divided the North American oriole into two species, while Jenny stood silently holding the poster the whole time.

So, while some of their role models were not entirely traditional, the students enacted traditional science roles at times in the science classroom in terms of who participated most regularly, who believed they had the most science knowledge, and who commanded leadership roles during skits and group work.

Summary of Research Questions Addressed in Section 1: The Science Classroom

After telling the stories from my data, I will now summarize how the previously presented data address each research question related to the science classroom.

- **How do classroom dynamics influence girls' and boys' participation?**
  - **Teacher-student interactions**
  - **Student-student interactions**

In this science classroom, several boys participate more frequently and more confidently than the others in the classroom. Only one girl (who was not a focus student) participates as much as these boys. The teacher interacts positively with the students in her class, often calling them endearing names such as honey and sweetheart. She makes an effort to call on girls and students who don't volunteer thereby diversifying the number of students who participate in class discussions. My observations of student interactions in a small group revealed that boys participate more confidently and frequently in this setting as well. John and Tommy perceived themselves as experts and were deferred to as experts more often than any of the girls in the group. These dynamics created a situation in which the boys participated more than the girls.

- **How does the science content under investigation influence girls' and boys' interest and participation?**

Participants did not indicate that there was any science content they disliked during this school year. Students indicated that they were interested in a variety of topics and the subject matter in Journey North was as interesting as the other units they had done. Tommy seemed to especially enjoy the study of animals and therefore studying the oriole was of interest to him. Likewise, Jenny was especially interested in the oriole because her grandmother was a birdwatcher. Jenny and Sally suggested they preferred hands-on activities to computers and therefore the format, not the content, decreased their interest in Journey North relative to other science units.

- **In what ways, if any, do the girls indicate that adolescence is a cultural initiation into femininity?**

Sally embodied many of the features described in the conceptual framework that indicate adolescence can be a developmental crisis for girls. Sally said "I don't know" frequently and portrayed a lack of confidence in herself and her abilities in the science classroom. Both she and Laura indicated that being nice was one of her best personality traits, which can lead girls to focus more on what they can do to please others than on what they should do for themselves. Sally also flirted with Tommy regularly throughout this study and seemed concerned about pleasing him by deferring to him in the small group discussion.

Jenny was also described as a nice girl and was extremely passive in group settings. While Jenny did not exhibit as many characteristics as Sally that would indicate she is heading for an adolescent crisis, her passivity may lead her to quietly opt out of science if she comes to believe it is not for girls.

To address this question more thoroughly, I would have to observe these girls over the course of several years to be able to indicate if adolescence brought significant changes to their perspectives and actions.

- **In what ways do girls enact feminine stereotypes in the science classroom?**
  - **In what ways do they resist these stereotypes?**

During my time in this science classroom, I observed girls enact a few of the stereotypes addressed in the conceptual framework. When allowed to self-select their seats, the girls chose (or agreed to be located) to the back and sides of the science classroom. This subtle choice could indicate their deference to the idea that science is a masculine domain. Girls' lack of participation in large and small groups relative to some dominant boys also follows research that girls opt out of science or that they find it inappropriate to be assertive in science. Laura stated that some girls who are assertive in language arts don't volunteer to participate in science.

As stated above, Laura also described Sally and Jenny as very 'nice'. Her stories indicated that this quality largely defined them in her mind and theirs. Sally especially fit the profile of an adolescent girl to whom it was very important to be nice and more 'cute than competent.'

Hannah was also 'nice' and not a consistent participant in large or small groups, but was more assertive than the other two female focus students. She resisted the female stereotypes somewhat through this assertiveness. In retrospect, I wish the one dominant girl in science had been selected as a focus student to offer more contrast.

- **What does the teacher say about gender differences in science?**
  - **Does she observe any differences between groups of boys and girls in terms of participation, interest and learning?**
  - **What kinds of variations does she note?**

Laura noted the participation discrepancies between boys and girls in her science class and in comparison with other classes such as reading or language arts.

She did not note any differences in interest and learning. Instead, she was proud that most, if not all of her students, really enjoyed science class.

- **How do students view science with regard to gender?**
  - **Do students observe any differences between boys and girls in terms of participation, interest and learning in science?**

The students did not have much to say about gender differences in science class during the individual interviews. Instead, when I asked them about differences, they jumped to differences in the computer lab. This could be because most of the Journey North project was spent in the lab and they assumed I was asking about that location. It could also be that they really didn't note any significant differences in the science classroom.

- **Are course materials gender biased?**

Course materials that I reviewed included the Journey North curriculum and the handouts that Laura and I made to go along with Journey North activities. The Journey North project is not gender biased and includes female science experts. This was not a relevant issue in this study.

- **Is their teacher gender biased?**

Other than the day I observed Laura pay more attention to the boys in the computer lab, I found Laura to be active in trying to avoid gender bias in science by calling on both boys and girls to participate in whole class discussions. In the questionnaire (see Appendix A) administered to the whole class, only one male out of twenty-one total respondents said he disagreed with the statement "My teacher thinks boys and girls are equally talented in science."

Section 2: The Computer Lab

As in the first section on the science classroom, this section is divided into two subsections, The Computer Lab Environment and Gender and Participation in the Computer Lab. The subsection on the Computer Lab Environment primarily addresses the following research questions.

- **How do classroom dynamics influence girls' and boys' participation?**
  - Teacher-student interactions
  - Student-student interactions
- **How do Internet computer activities influence student participation and interest in science activities?**

The subsection entitled Gender and Participation in the Computer Lab primarily focuses on the following research questions.

- **In what ways, if any, do the girls in the classroom indicate that adolescence is a cultural initiation into femininity?**
  - In what ways do girls enact feminine stereotypes in the computer lab?
  - In what ways do they resist these stereotypes?
- **Does the notion that girls are motivated by human connection seem to hold true when the Internet is used in the science classroom for communication and collaboration?**
- **What does the teacher say about gender differences in computer technology?**
  - Does she observe any differences between groups of boys and girls in terms of participation, interest and learning?
  - What kinds of variations does she note?
- **How do students view computer technology and the Internet with regard to gender?**
  - Do students observe any differences between boys and girls in terms of participation, interest and learning in the use of computer technology?
  - Are course materials gender biased?
  - Is their teacher gender biased?

I was unable to address the research question '**In what ways, if any, do students find that the Internet culture differs from the larger computer culture?**' in this study. This was identified as an important question from the literature reviewed regarding the culture of computing, but the time and scope of this research project did not allow the opportunity to delve into issues about the culture of the Internet. Additionally, the lack of experience among participants with the Internet limited their ability to formulate ideas and/or articulate any differences.

The Computer Lab Environment

On a typical day during the project, after an introduction in the science classroom the students walked outside the science classroom to the computer lab in the main building and spent about thirty minutes working in the lab. The lab had 19 IBM format computers arranged in a U-shape with desks in the middle of the room. Teachers were able to sign up to use the computer lab and could send students individually to the lab to work on reports and such throughout the day. Therefore, even when Laura had the lab reserved for her class, there might be several other students there. The computer teacher was often in the lab when her class arrived. He would generally sit at a computer and work quietly on his own. He did not interact or offer to help Laura or her students while in the lab.

Students were free to select their own seats except when I rearranged them for videotaping purposes. Most students chose to work independently at a computer, though some worked regularly with a partner. Partners were always same sex pairs, except toward the end when some research participants chose to work together since they had already been told to sit together. Laura did not allow them to work in groups of three. Before I began taping, boys sat on one side of room and girls on other with the exception of one girl on the boy side and two boys on the girl side working together. Some days were louder than others in the lab, and students were more off-task when they worked with a partner. Generally, the noise level was a bit quieter in the computer lab than in the science classroom.

Laura's role in the computer lab differed from the science classroom. It was not teacher-directed in the lab; students worked independently. Laura spent her time circulating and helping students individually in the lab, and only occasionally broke in to comment to the whole class. Students often had to wait a long time to get help from the teacher because so many students requested help with the activity or with their computer.

Time spent in the computer lab was also interrupted with problems that were very frustrating to Laura and her students. The most significant problem was the slow speed of the computers. Some days were worse than others and it appeared that bad weather and too much network traffic impeded their operation. Some days felt like a waste of time when students sat and waited for five to ten minutes to get on-line.

> Hannah and Sally are chatting about Sally's password while waiting to check Sally's email account.
>
> Hannah: (raises hand, I come over) This is taking too long, it won't even go in.
>
> Megan: Yeah, all of these are slow, I don't know what to tell you.
>
> Hannah: Finally!
>
> Sally: You have zero messages.
>
> Hannah: After all that you have no messages?!

Other problems included computer screens freezing up so students had to restart their computers, getting kicked off the Internet in the middle of class, and screens showing no back button so students had trouble navigating. Occasionally, these events became significant barriers to productivity when the students only had about thirty minutes to complete an activity in the lab.

Student Interest in Computers and Journey North

Despite these frustrations, interview and questionnaire data revealed that most students enjoyed going to the computer lab and the freedom that came with it. Students were able to choose to work alone or with a partner and at their own pace. They enjoyed many of the unique features of the Internet project; one was the access to multimedia learning tools such as songs, videos and animation. One example of this was when students downloaded and listened to the oriole song in the lab and compared the dialect between several species. Students had been noticeably loud and off-task that day in the lab until they came to the part when they could listen to the song. All students tuned in, the room became quiet except for the songs and the students who hadn't read to that part of the oriole update were eager to get there to hear the song on their own computer. Bits of discussion erupted afterward about the song and one boy said loudly, "That's cool." Laura replied, "It is cool." Students were also generally excited about the opportunity to communicate with others via the Journey North project. While this class participated in this aspect of the project minimally, they were still motivated by it. The class drafted friendly messages to another class from a distant state. Laura had communicated with a teacher she found on the Journey North website in the teacher exchange forum. They arranged for their students to become pen pals for the project. The students also generated questions for the oriole expert, Dr. David Aborn, who replied personally to them via Laura's email account. It became obvious that the students were highly interested in the communication aspect of the project during my observations and from the student interviews and questionnaires. For example, the day that Laura introduced the classroom email exchange activity in the science classroom, the students quickly quieted down and appeared very engaged with her presentation of the email correspondences she had with the other teacher. In the lab, several students were outwardly enthusiastic when they received their first reply from the distant students. The noise level in the lab increased as other students came over to the girls who received the first response. Reading the message from the pen pals, the girls replied "Cool!" and said aloud "I like Chinese food too!" in response to the personal information in the message. Even Tommy, who desperately wanted a message and only got one from the expert, stated he liked the idea of communicating with others in the interview.

> Tommy: What I like about the Internet is getting on email and chatting even though I haven't gotten a response.
>
> Megan: I know you didn't get one. That was a bummer.
>
> Tommy: And, well I got one response from that guy. He was real nice, showing us how, when the bird picks a mate.

Most of the focus students indicated that they liked the up-to-date-ness of the information they could get on the computer and how fast it was compared to traditional research methods. Here are some of the their comments about these positives of using the Internet.

Hannah: I like it because if the Internet is not too slow then you get information really fast, and not having to look up in the index and then turning to the page and then reading through all the paragraphs. You know. It's just faster to get all the information real quick.

John: Well, I think it helps because you've got more of a wider selection of information than books, you know, like checking out books at the library. Because if those books have been checked out by another person, you don't have that information. You have to get it somewhere else. Whereas the Internet, one person could be on one computer and another person could be on another computer, and they could both be getting the exact same information.

Sally: Well, if you look like in an encyclopedia you wouldn't have found out where they migrate, where, well you might have found that out, but where all the sightings have been this year. You couldn't find *that*, and you can on the Internet because people have the Internet and they can put it on there. But, it's been a lot better than using an encyclopedia. That's how we did it at our old school, we had to use encyclopedias. We couldn't use Internet because we only had one computer per classroom. And all the labs were taken by students all day long, because we had a lot of students. You couldn't just go in there, and besides, only the classrooms had Internet access.

Megan: So you didn't have an Internet lab? Okay. So is there anything else that you thought doing research on the Internet was, you said you thought was better.

Sally: It was fun, and it was better by using, it helped, it actually showed pictures of the oriole, because I had no clue what the oriole looked like. And so it, the encyclopedia wouldn't have the new updates like the Internet would. And the Internet, just like every day there was new stuff. And the encyclopedia, they can't make an encyclopedia every single day. So, it was better by having updates.

Data presented in this section address the research question, How do Internet computer activities influence student participation and interest in science activities? These examples illustrate that students were interested in many aspects of using the computers and the Internet in science. The novelty of the going to the computer lab and exploring unique features of the Internet via the Journey North project was highly engaging for most students in the class. I will continue to address this question in the next section.

Dislikes of Computers and Journey North

While many features of the Internet project positively influenced students' interest in science activities, some aspects proved distracting. When asked what they didn't like about using the computer or the Internet, the most common response was that they were often too slow.

> Hannah: But what I dislike is like, it was distracting me whenever I just had to sit there and wait for it, and I was like talking to my friends and just waiting.

The slowness of the computers was addressed as a dislike in all the focus students' and teacher interviews and in the questionnaire that was completed by the whole class at the end of the project. Also, students who were new to using computers were often more easily frustrated and had more negative responses to the experience than those who were comfortable using them.

Two boys also indicated they thought the Internet can be bad for kids and this was present in their minds during the project. One of these boys was John. He was the only focus student who did not have a computer at home and he expressed the most wary attitude toward them. In the interview, John expressed his reservations about using email.

> John: Well, no I haven't done email before this.
>
> Megan: So you learned a little bit how to do that? What did you think of that?
>
> John: I think it's okay if you don't abuse the privilege.
>
> Megan: What do you mean, abuse it?
>
> John: Like, start going, "Hi! Anybody want to…." You know, I think it's okay if you, like, can trust the people that, you know….
>
> Megan: That you're talking to?

John: Uh huh.

Megan: So mostly…you wouldn't really be interested in just finding random people to talk to. [Yeah.] But it was okay with another class where you knew they were in the project or something?

John: Yeah. Yeah.

He also felt uncomfortable with advertising on the Internet that he viewed at school.

Megan: Was there anything distracting about learning on computers?

John: Well, sometimes they can be slow, and you know sometimes the commercials that come on, you know, like, "Click here to win 3000 dollars!!" They come up on the top part of the screen. I don't like those.

For John, his fears of the intent of people he might meet on the Internet seemed to limit his interest in using the Internet in science slightly, but not completely. When I asked him if he was more interested in the hands-on projects or this Internet project in science class, he replied, "I think that the computer is a little bit more [interesting] because, you know, at my age you're wanting to deal with electronics and stuff like that."

Jenny and Sally had other criticisms of the Journey North project. While Jenny generally enjoyed the project and liked learning about the oriole, she thought that focusing on research every day became boring and she preferred many of the other science units she had done this year.

Jenny: I like computers. I like using the Internet. But when I had to do my report, I had to do it every day, so I got a little bit boring.

Megan: In this project? Just going in and doing the research?

Jenny: Yeah, I worked on it too. And sometimes I couldn't find the information that I needed. It was a little bit hard.

.....

> Megan: So how do you think that this Journey North project compares to other units you've done this year? Did you like one or the other better?
>
> Jenny: Um, I thought I liked, I like doing things with my hands, so I like to do like hands-on things.

Sally also wished there had been more opportunities for hands-on experiments during the project and never felt confident in her ability to use the computer. Her lack of confidence limited her enjoyment of the project. Hannah's criticism was that she wished she could have explored some of the other migrations in the project besides the oriole. These data show ways in which Internet activities limited some student interest in science activities.

<u>Participation in the Computer Lab</u>

Now I will address the research question regarding how student interactions and classroom dynamics influenced student participation in the lab. For the most part, students worked alone at a computer and stayed on task in the lab especially when the task was clear and challenging. When students worked with a partner, they were generally less on task than when they worked alone. I observed this frequently with the focus students who were grouped together in one corner of the lab for easier videotaping. Over the course of the project, Tommy and Sally began working together more often and flirting with each other. Flirting behavior included touching each other on the arm, bumping shoulders, sitting close to each other and playful teasing and hitting. Hannah worked with Sally sometimes as well when Tommy was on his own computer. John and Jenny always chose to work alone and only worked with a partner when they were forced to because of computer problems. Off task behavior when working with a partner was most often general socializing; talking about television shows, telling jokes, discussing what they want to do when they grow up. Occasionally students working together would argue about who got to use the mouse or who would do what on the computer, but this was not observed among the focus students.

Tommy was most off-task among the focus students. He was highly sociable and would talk with anyone who would talk with him. While some days he worked alone on a computer, he preferred to work with a partner. He didn't have a consistent computer partner so he worked with various people in his corner of the room throughout the project. One day Tommy was "caught" on video-tape sexually harassing the girls working next to him.

> Megan: I'm sorry you haven't gotten a message back, Tommy.
>
> Tommy: That's alright.
>
> (Tommy is messing with the microphone, then messing with Melissa's mouse and keyboard. Flirty, off-task behavior, though he's sharing a computer with John and I can't tell what John is doing with it. Tommy is typing something in when I come and stop him. He's typing his screen name in the wrong place to get to database. Once I leave he's back to messing around, talking with Melissa.)
>
> Tommy: Hey, was that yours on the stairs?
>
> Melissa: What?
>
> Tommy: Was that yours on the stairs, outside? Down off the balcony. (Covering his face toward camera.) It's a condom (whispering).
>
> Melissa: Oh my God!
>
> Tommy: laughs
>
> Melissa: What are you talking about?
>
> Tommy: I'll tell you later. Shh. (He turns off microphone volume and says something to girls. Microphone back on, later repeats,) Tell ya later. (Turns

off microphone again and holds folder up to his face and says something to Melissa again. I come over to pick up microphone at end of class, notice it's off. He innocently says he turned it off.)

Melissa was not enjoying the conversation when it turned to condoms from the tone of her voice when she said, "Oh my God!" Since Tommy turned off the microphone and I was not there watching this scene, I missed what transpired next. This example is about both participation and gender in the computer lab. It belongs in this section on participation because it is one example of Tommy's off-task behavior in the lab. Turning off the microphone is the type of behavior that branded Tommy a "little turkey" by Laura; as stated earlier she referred to him as an "adept manipulator." He innocently told me he turned off the microphone as if he just turned it off at the end of class when I came to collect my equipment.

This example is also about gender because it illustrates one type of sexual harassment that adolescent girls experience in school. Here Tommy's flirty behavior went over the edge into harassment because, as stated in the conceptual framework, it left the girl feeling bad rather than good about herself. While I observed lots of flirting between boys and girls, I only observed sexually inappropriate comments one other time. Another day I overheard two other boys who weren't focus students make some comment about bisexual contact to the girls sitting next to them. This was not captured on video so the details are missing. Perhaps the freedom to work independently in a less structured environment created more opportunities for off-task behavior, socializing, and sexual harassment than in the science classroom. Students who were not very self-directed, like Tommy, spent more time off-task than those who were focused, like John and Jenny.

Gender and Participation in the Computer Lab

In this next subsection, I will explore data that address my research questions related to gender.

- **In what ways, if any, do the girls in the classroom indicate that adolescence is a cultural initiation into femininity?**
- **Does the notion that girls are motivated by human connection seem to hold true when the Internet in used in the science classroom for communication and collaboration?**
- **What does the teacher say about gender differences in computer technology?**
- **How do students view computer technology and the Internet with regard to gender?**

Gender differences in the computer lab were even more pronounced and obvious than in the science classroom. While I did discover some differences (only upon review of data from the lab), I noticed more differences at the time of my observations than I did in the science classroom. For example, the first day the students went to the computer lab, many of them needed help learning to operate the computer software, getting on-line to the Journey North website, and filling out the worksheet guide Laura made for them. As in the science classroom, when allowed to select their own seats, the boys primarily sat on one side of the lab and the girls one the other. Therefore, it became very obvious when Laura spent the vast majority of her time on the boy's side of the room attending to their questions much more than to the girls'. Laura easily fell into this pattern of attending to the boys more because they were much more demanding of her than the girls, just as reviewed in the conceptual framework. The girls raised their hands quietly longer than the boys did and Laura did not even see them. While the boys started raising their hand when they had a question, they soon tired of waiting and shouted out their teacher's name or even got out of their seat to get her to come help them. I noted in my field notes that there were simply too many questions for one teacher to handle adequately. Students who didn't get help were stuck waiting and soon got off-task. I observed one boy pull the keyboard off and put it back on, two girls mess around with the CD-ROM drive, two girls watch a boy who was playing on his computer, and two girls tell jokes and have a discussion about smelly feet. While some girls also called out the teacher's name to get help, they did this with less frequency and volume than did the boys. Despite some of the girls' off-task behavior, the boys' side of the computer lab was much louder in general.

This pattern did not last very long for two reasons. Soon afterward, I began videotaping and divided the students according to who consented to participate around the lab, thereby disrupting the boy/girl division. I also grouped the three girls and two boys who were focus students together to facilitate my observations. Also, at the end of the first day in the lab, Laura and I chatted about how it was going. She was disappointed with how much help the students had needed in the lab, frustrated with some students' misbehavior, and flustered that so many did not understand how to complete the worksheet she thought was straightforward. She added that she did not notice any gender differences. I then shared with her my observations of the boys' domination of her time in the lab and she was intrigued. As someone who had previously read books about gender differences and attended a workshop promoting girls' greater participation in math and science, she was aware that this was a potential problem and decided she would pay more attention to it in her classroom. After this first day, she spent more time circulating around the entire computer lab.

Boys as Experts

As in the science classroom, boys were more often perceived as computer experts by themselves and by their peers than girls. This was evident in both my observations in the computer lab and in my interviews with the focus students and the teacher. Given that most of the students in this class were relatively new to computers, it is especially interesting that boys were looked to as experts, and wanted to be experts when they were and weren't more knowledgeable than girls. I did not survey each member of the class on their experience and knowledge, but this pattern arose among the focus students and Laura observed it generally among the whole class. The following chart briefly summarizes the focus students' experience with computers and their corresponding willingness to ask for help or give help to their peers. These assessments were based on my observations and review of video data.

Table 4.3: Students' Experience Level with Computers

Student	Experience/ Knowledge	Asks for help	Gives help to peers
Sally	Low	Frequently	Never
John	Low	Rarely, if ever	Rarely, if ever
Tommy	Average	Sometimes	Sometimes
Jenny	Average	Frequently	Never
Hannah	High	Sometimes	Sometimes

Sally freely expressed her frustrations and dislikes of using computers with others in the lab and often asked for help. John, who was also a novice, perhaps even less experienced than Sally, never complained about his lack of knowledge or expressed any frustration. I rarely, if ever, observed him ask for help on the computer though there were days when he sat there and did not make much progress on his assignments. Therefore it appeared that John was uncomfortable admitting his lack of knowledge and sought to present himself as knowledgeable and comfortable with computers even if he wasn't. Perhaps his presentation worked. While I observed John to be a novice, Tommy disagreed. In the interview I asked Tommy if he noticed any difference between boys and girls in using computers.

> Tommy: Well boys, they seem kind of faster than girls. I don't know why but like John, he's really getting fast on it. And the girls, they're getting up there, but, you know, slow.
>
> Megan: In terms of how to use the computer? [Tommy: "Yeah."] Okay. What about using the Internet and email? Do you think there's any difference?
>
> Tommy: Not really.
>
> Megan: Why do you think that's different than...like you were saying John is real quick but...
>
> Tommy: Because he knows what he's doing and stuff.

If Tommy viewed John this way, perhaps others did as well.

At the other end of the spectrum, Hannah was quite experienced and comfortable using computers. She asked for help if she needed it and helped her peers if asked. I only observed her helping someone she was working with as a partner. She was not sought out as a resource by others in the class who weren't working beside her. Hannah did not view herself as an expert. In the interview she stated,

> Well, the two kids in the class that know the most about computers are boys, so that's like one difference, because girls are into hands-on, you know, because computers are hands-on, but you know like making stuff. And then at the computers, the boys are like, "Oh yeah, you just click on this" and stuff....
>
> Megan: You think some of them knew more about how to....

Hannah: Yeah, because they spend more time on that than like talking, or just being fun.

As reviewed in the conceptual framework, girls, like Hannah, who were experienced and knowledgeable about the operation of computers and navigating the Internet were likely to view other experienced boys as more knowledgeable than themselves. In fact, none of the focus students were sought out as experts while several other boys in the class were more assertive in accepting this role. Laura observed this discrepancy as well.

> I just think, especially in the beginning, I mean, well it's just like, all right, think about in the computer lab, you know, and I'm thinking of Danny, I mean there are some of those boys that just came in and they just kind of took over and they were very, I don't think there were *any* of those girls that came in and took over at all. And if somebody had a problem… [Megan: "Nobody went to them."] Yeah. Nobody went to them. And it was usually those three or four boys that, you know, come help me, come fix this problem, and all this kind of stuff.

Sally also thought boys were generally more experienced with computers. When asked if she noticed any gender differences with computers she said,

> Not really. Or, well, the guys seem to know more about the Internet than girls. It's probably because girls aren't into, I don't know how to say it, but guys are just, they seem more Internet access.
>
> Megan: Like that they've done it more? Have more experience?
>
> Sally: Yeah. Like they use it a lot more than we do.
>
> Megan: Do you think that that's just like they use computers more, or the Internet specifically?
>
> Sally: Computers and Internet.

When Sally needed help in the computer lab, she often asked the boys around her first. If they couldn't help her, then she would raise her hand for Laura or myself to help. For example, when the students were first writing and sending email messages to the students in Pennsylvania, Sally was lost despite the fact that she had a step-by-step instruction sheet in front of her. She first asked Tommy for help posting her message. He took her keyboard and typed the information for her. He then took her mouse and clicked it for her when she kept asking "Now what do I do?" Moments later, she turned to another boy for guidance. "Hey Hunter, where are you?" When he didn't respond she raised her hand and I came to help her draft and send an email message. Tommy and Hunter were sitting on her right and Jenny and Hannah to her left. Later in this period, she socialized with Hannah and Jenny a bit and asked what they were doing, but did not ask them for help.

In another exchange I observed in the lab, Sally was very clear about her belief that boys, not girls, were to be viewed as experts.

Hannah: What do we go to now?

Sally: I don't know. Ask Tommy.

Hannah: Tommy, what do we go to now?

Sally: He's the man sitting here.

Tommy: Did you read all of the thing?

Hannah: Yeah.

Tommy: Then I don't know, did you check your mail?

Sally: Did you get your map done?

Hannah: No, but I don't have it with me. I have to do it at home.

Hannah is asking what to do next, not how to operate the computer, but regardless of the topic, Sally finds it appropriate to ask a boy. It is somewhat notable that Hannah takes Sally's advice to ask Tommy because "he's a man." Tommy is one of the most off-task students in the class, more interested in socializing than academics. Of course, Hannah is just going with the flow of the conversation and we don't know what she really thought about Sally's comment, but nonetheless, she didn't challenge it. And Tommy is happy to accept their idea that he might know what is going on as he suggests tasks she might complete.

In one final example, Laura recounts a story about a group of former students who come to her classroom each morning. In this small group, the boys are more interested in using computers than the girls and the girls seem to criticize the boys for their interest. The example also illustrates gender role-playing in the classroom as reviewed in the conceptual framework in which a girl assumes a support role for a boy.

> Laura: It's interesting because before school I have a group of kids that come in in the morning. And there are three boys and three girls who come in, there's about six of them, and the girls will come in and they'll say something about, "Oh, you're always on the computer." But if they come in first, they don't get on the computer. [Megan: "The girls don't."] No. They don't. And it's really interesting, because these are super bright kids. But the boys are always on them.
>
> Megan: Really? Which boys are they?
>
> Laura: They're seventh grade boys that I had last year. It's seventh grade kids that I had last year. And I mean we're talking exceptionally bright kids. Now sometimes they'll come on and they'll look up stuff, they have an e-trade so they come in and look up their stock market stuff. But then they'll come in and sometimes they'll play games and all this kind of stuff. But, this was this morning, one of them came in and had a report to do, and what does he do? He asks *Briana* if she would type the report for him. I'm dead serious. [Megan: "Did she do it?"] Yes. So....
>
> Megan: And nobody, none of them had any problem with any of that? [Laura: "Huh uh."] The girls...and what did he do while she typed his report?
>
> Laura: Oh I don't know. He was just messing around. [Megan: "Oh my...."] He said, "You are *so* much faster than I am," and she goes, "Yeah." I mean, I

don't know, she types 50 words a minute or something, I don't know, I guess she had computers or something, but I just thought….

Megan: So there was a reason why he asked her?

Laura: Yeah, but I still thought that was interesting because he's the kid that's on the computer all the time. And he's on it at home. I mean, he's the one that has the e-trade account and all this kind of stuff. But isn't that interesting? So, you know, I, it's kind of interesting….

Megan: Like when you look for it you can see it.

Laura: Yeah. If you really start paying attention to it and, you know, from my limited knowledge which is, you know, just here, yeah, it's definitely, it's a man's, it's a man's deal.

Laura concludes with the comment that computers are "a man's deal" as she observes it in her classroom. I interpret this to mean that boys are the experts on computers. They view themselves as the experts and the girls do too, regardless of the experience level of the girls. These data support the concepts reviewed in the framework for the study that computers are a male domain.

Participant Views of Gender Differences

Laura and the focus students were all asked directly in their individual interviews if they observed any differences between boys and girls in science and with computers. Many of Laura's comments have been reviewed previously. The students had a more difficult time than Laura making sense of the differences they observed. They waffled or contradicted themselves sometimes but generally characterized gender differences as unique interests and ways of acting. The following chart summarizes some of their comments about gender differences with regard to computers.

Table 4.4: Quotes Regarding Gender Differences in the Computer Lab

Participant	Using computers	Using Internet and email
Hannah	Girls work together more Boys just sit there, relaxing (e.g. not interacting) The two kids in the class who know the most about computers are boys.	Girls write GTG "got to go" Boys write "stiff stuff"; it's just boring
Sally	Boys use computers more	Guys seem to know more about the Internet than girls It's probably because girls aren't into (it), I don't know how to say it.
Jenny	(Makes no clear distinction between boys and girls) If everybody didn't fool around, they would all get done in time.	Some people don't like to type, some people don't like to read that much, so if they got emailed back, they might not read it
John	Girls have their certain types of opinions and we have ours. There's really no difference, except for the point of views.	Girls "are like 'Let's go shopping!'" Boys "Well let's get all the information and then we go to WWF" (world wrestling federation)
Tommy	Boys, they seem kind of faster than girls. Girls, they're getting up there, but, you know, slow.	Not really (any difference).
Laura	Boys have more experience, confidence and interest; "took over" in lab	Girls do chat rooms, not boys

The students did not say they observed clear gender differences in the science classroom, but each had more to say about such differences in the computer lab. The excerpts from their interviews in the chart above reveal that most participants believe that boys are more experienced with computers than girls. Only Jenny and John were reluctant to say that one was more knowledgeable or extremely different than the other. John reconciled any differences he observed by saying that the sexes just have different points of view. In fact, he had a lot to say about this issue in the interview.

> Megan: Okay. So in your science class in your school, do you think there are any differences between boys and girls in your class in science in terms of what they say, what they do?
>
> John: No. Well, yeah, I mean girls have their certain types of opinions and views and we have ours.
>
> Megan: And those are different? [John: "Uh huh."] Like how?

John: Like, have you read the book *Women are from*, like, *Men are from Mars, Women are from Venus*? [Megan: Uh huh.] It really goes into direct detail on the different views, like how a man thinks if he buys his girl a $3,000 ring, he thinks he's done for the whole year, whereas the woman, yes that's okay, but she would like the little things also.

Megan: Right. Did you read that book?

John: No, but my mom has.

Megan: And she talked to you about it? [Laughter.] Okay. So you think things like that you see in your class?

John: Yeah. I sort of notice it a little, you know, it's not as *defined* in our age, but as we get older, I'm pretty sure I'll be able to see it.

Megan: To see it more. So you don't really think there's any difference between boys and girls in science in terms of how much they know, or how much they like it or anything like that?

John: No, it really depends upon your experience, what you have, and your interests. It depends upon that.

Megan: More than anything else? [John: "Yeah."] Would you say that's the same when you talk about computers? Like that, there's no difference?

John: Yeah. There's really no difference, except for the point of views, is really it.

Megan: So what would be a difference in point of view on computers between boys and girls?

John: Well, I mean, girls are like, "Let's go shopping!!" They're like that at this age. And we're like, [assuming a humorous voice] "Well let's get the information and then we go to WWF."

Megan: [Laughing] Okay, so kind of interests. Things that you like are more different. [John: "Yeah, interests."] Do you think it's the same thing with the Internet, or do you think the Internet is any different than computers, like email and Internet, do you think that would be any different?

John: No, it's the exact same way. It's just your point of view.

John tried to present these differences as value-free to avoid saying that boys or girls were better at something than the other. However, at one point he implied that boys might be more focused on school tasks than girls when he said boys would first "get the information and then go to WWF" while girls would just say, "Let's go shopping!"

Jenny and Tommy were the only two who mentioned something along the lines of equal opportunity with regard to gender differences. Jenny would not indicate any differences between boys and girls. Instead, she said "Using computers, I think that everybody if they didn't fool around and all that stuff they would get it all done in time. So, I think everybody has like a chance to do that." There is an underlying implication that she thinks some people, and perhaps some group(s) of people, are more likely to fool around, but that it is only their choice. Tommy stated that girls have "got to have the privilege that we do. And that's not right if they don't do it because that's just not right. Because they ought to get the same opportunity that we do." He made it clear that he thought differences shouldn't exist, but they do. He went on to say that with computers, "girls, they're getting up there, but, you know, slow."

So, with the exception of Jenny and John, the focus students and Laura made it clear that they perceived boys to be more experienced, knowledgeable and interested in computers than girls. As Laura said, in her classroom, computers are "a man's deal."

Is the Internet Different? One purpose of this study was to investigate whether using computers for communication and collaboration would alter this pattern and lure more girls into computers and science. I asked, Does the notion that girls are motivated by human connection seem to hold true when the Internet is used in the science classroom for communication and collaboration? This small data set is not enough to discuss altering patterns, yet Sally proved an interesting case to examine in this regard. Sally indicated in the interview that she really liked science but not computers. At the beginning of the Journey North project, she was vocal about her lack of experience with computers and her dislike of them. While her comfort level improved over the course of the project, she still did not like computers at the end. She stated "I'm not a computer person" more than once and persisted in her belief that she was still a computer novice at the end of the project. However, Sally viewed using email as a separate entity from computers, one that was appealing and uncomplicated. Reviewing parts of her interview at the conclusion of the project illustrates this discrepancy and raises the possibility that communication could be a positive vehicle to improved computer literacy for students like Sally.

> Megan: Okay, do you have a favorite subject in school?
>
> Sally: Well, my favorite subjects are science and social studies. Those are my favorites.
>
> Megan: Okay. Great. So now I want to ask you a little about using computers in general. What are some things that you, what is your experience with computers?
>
> Sally: I haven't used computers a lot. This is probably the first time I've used them at school, like Internet. At my old school we had to use them a lot for reading comprehension and math. But here we don't have that, so it's, this is the first time Internet. And now at home I'm getting on the Internet more because of the school, you know, brought me to it. So now I'm into Internet now.

> Megan: So what are some things you like about computers in general. And more like, let's just talk about not the Internet. Let's talk about other things with computers that you like and don't like.
>
> Sally: Well, I don't really know too much about computers.

Sally has labeled herself as a computer novice as she repeatedly answers questions about computers with the comments "I haven't used computers a lot" and "I don't really know too much about computers." Throughout the interview, Sally vacillates as to whether she has learned anything about using computers and whether using the Internet has improved her attitude toward them. She continues by recounting her experiences with computer-assisted instruction programs that may be responsible for her negative attitude toward computers.

> Megan: Well, think about those projects you did at your old school, like the reading comprehension and....
>
> Sally: Well, the reading comprehension is just, if you were having a hard time in reading you would have to go, we'd go in there for about an hour. And you'd have to go for thirty minutes reading and then thirty minutes math. And I liked the math section more than the reading because I don't like reading. And most of it was reading a paragraph and then answering questions, and I had (I was one of the lower students) I didn't, you know I don't like to read. I didn't really comprehend that much.
>
> Megan: So it was kind of, you would just go in by yourself and work....
>
> Sally: Well actually we would go in with the whole class and everyone had to go in and if you were really good at the reading you'd only have to go do the math. Or if you were really good at math, you'd do reading. But I had to do both. And sometimes if you were really good, like we had to go twice every week I think it was, and I would do math for one, I'd do math and then reading, and then the other time reading and then math, and then if I had extra I could go into a game. And just play games. Or it would stop you in the math or stop you in reading and it just takes you to a game. And then you go, when the game's over you click and then you go to your math session or your reading session.
>
> Megan: Is there anything that you liked about doing those kind of programs on the computer?

> Sally: I liked the math. I didn't like the reading. Not much.
>
> Megan: Just because you liked math better? [Sally: "Yeah."] Was there anything that you just didn't like about using computers like that?
>
> Sally: I never did like computers because I thought they were complicating to get through, and so I never used computers except at school. And when we did, I just always complained, I didn't like the computers. I just hated it in there, because some kids would get done early, like some kids would get done in 30 minutes, and the session was over and then they have to go sit on the wall. And I was never one of those. I was always the one having to stay like five minutes after our session was over to finish, because it times you and if you're doing bad they go over time. So it was really bad for me. [Megan: "It was frustrating?"] Yeah. I didn't like it.
>
> Megan: So you talked a little bit about you didn't feel like you were very good at using them, like they were kind of confusing to get around. Do you feel like you are learning a little more about that now?
>
> Sally: A little. Not much. Like I can go, if you have a list of things I need to do, like click this and then click this, I can't just go to a computer and.... If someone tells me, I won't remember it, and I'll be like, "What was that again?" But if it's written down I can... [Megan: "You can follow directions?"] Yeah I can follow it. But I don't know computers that well. I barely even know Netscape Communicator.

As suggested before, Sally struggles to determine how much she has learned about computers during this project and whether this experience will change her attitude toward computers. While earlier she said, "I'm into Internet now," here she says she barely even knows Netscape Communicator. The logistics of navigating computer screens are an impediment for her. But she continues to try to create a distinction between the Internet and computers.

> Megan: How to get around, and what these buttons mean, and all that stuff? Okay. So now let's talk a little bit about the Internet. What are some things that you like about the Internet?
>
> Sally: I like the Internet because it's useful, you know you can pull up stuff that you didn't know, or did know, or you can chat on-line, or you know, talk. Just figure out information and file reports and stuff. I like that.

> Megan: Are there some things that you don't like about the Internet?
>
> Sally: I don't like how it, you have to go through several steps to get there. I think there should just be a button INTERNET and you just click on it and it just comes up and you're there. That's what I think.
>
> Megan: Is there anything else that you didn't like about it, or was frustrating working on the Internet?
>
> Sally: I didn't really like, I don't like doing reports on the Internet because, like finding the information, you have to go through so much stuff, and I'm just one of those people that doesn't have all the patience in the world. I just like to get there and it's over with.
>
> Megan: So sometimes it took too long to navigate through all those things? [Yeah.] Okay. How do you think that what you've done on the Internet is different than other computer things, like those tutorials? Is there anything that you think is different about them?
>
> Sally: Not much.

Here again, Sally cannot make a conscious distinction between her prior experience with computer tutorials and this Internet-based project. But the following excerpt reveals that a clear distinction emerges when she uses computers for communication.

> Megan: Okay. What do you think you learned about computers during the project?
>
> Sally: I learned that the computers are a useful way of getting things, instead of having to look in books for everything. And I learned more about the Internet than I knew about the Internet. My dad uses it, but I never got on it, so I didn't know much of it.
>
> Megan: You learned a little more about how it works? So you said now you say you're using it at home sometimes? What have you used it at home for?
>
> Sally: Like, on nights that, or the days that I didn't get the oriole stuff done because the computers were going too slow, I could go home and get on really fast and just know I could jot down everything I need to know. Or, I chat to a lady in Australia a lot. [Megan: "Oh really?"] Yeah, my dad's known her since, for a year now. So that's pretty cool.
>
> Megan: How did you start doing that, with that lady in Australia?

Sally: I don't know. My dad likes to chat on-line a lot, and he was down there and he saw this lady and they were chatting and he just put her in his file and now he can log on and we chat a lot.

Megan: So you talk to her too? Do you write her your own messages?

Sally: Yeah. We have I See You, and sometimes we can take pictures and then send them to her and then she can send us pictures. A lot of times if our camera is set up we can actually see each other on the Internet. [Megan: "So you do that?"] Yeah, sometimes. We did that last year a lot. [Megan: "Do you like that?"] Yeah. It's pretty cool.

Megan: What are some things that are kind of neat about chatting with someone from so far away?

Sally: Um, you find out what their hobbies are, what they like to do, how old they are, like where they live, what their jobs are, what animals they have, stuff like that. Or just, the other day we were chatting and I was telling her about school, and she's telling me about her job that she has and everything.

Megan: So just it's fun to talk, to meet people, and talk to them, find out about them? Did you learn anything about using email during this project that you didn't know before?

Sally: Not really. I knew pretty much email. Because my dad, I sit there and watch my dad chat.

Megan: Right. Okay.

While Sally is a spectator watching her dad use the computer for communication, she is also a participant writing her own messages and using video software to chat with someone on the other side of the world. At the time of our interview, I was shocked when Sally brought this up. From all her prior comments and actions in class, I assumed she had no experiences with the Internet before this project and I was surprised when she discussed this email experience at home. Sally clearly separated the two and presented her use of email as unproblematic, whereas she presented her other interactions with computers as complicated and frustrating. Perhaps this was because her dad was taking the lead at home and she was on her own at school. Perhaps this was because her school experiences with computers had been negative and her home experiences positive. Perhaps this was because she was confident in her ability to communicate socially via email and not confident in her ability to understand computer machines and their software. Perhaps this was because she developed a helpless learning orientation to computers as a result of her previous frustrations and failures with them in school. I was not able to follow-up on this with Sally and even if I had, I'm not sure she would have been able to articulate the difference. However, these comments raise an interesting question as to whether using the Internet for communication over time might increase Sally's confidence with computers in general.

Summary of Research Questions Addressed in Section 2: The Computer Lab

- **How do classroom dynamics influence girls' and boys' participation?**
  - ***Teacher-student interactions***
  - **Student-student interactions**

In the computer lab, most students worked independently. When they did so, they were generally on-task and occupied for the entire class period. Students who worked with a partner were more off-task at times. This was especially true for Tommy who was more interested in socializing than working. He constantly looked for opportunities to socialize and flirt with girls around him. For Tommy and students like him, the freedom in the computer lab to go at his own pace and socialize detracted from his participation in the activities. For Jenny, however, the freedom to work alone and in an environment that was a bit quieter than the science classroom helped her accomplish her assignments and participate in the curriculum without distraction.

Laura had a hands-off approach in the computer lab and spent her time circulating to address students' questions. This approach was helpful to students who were on-task and were not interrupted with additional instructions in the lab. When there were many students who needed help simultaneously, though, some students could not participate in the curriculum because they had to wait a long time to get help from their teacher.

- **How do Internet computer activities influence student participation and interest in science activities?**

Using the Internet and email was popular with students. In the whole class questionnaire, only one male student said he did not enjoy using the Internet and no one said they disliked using email. In the classroom, students exhibited an eagerness to participate in email and in the interviews, several focus students indicated that they liked the unique features of the Internet such as the up-to-date information and access to multimedia that are unavailable in books. While John expressed some hesitation with using the Internet and email, he did not indicate that his fears and dislikes detracted from his interest in the project. In fact, he was very interested it. The repetition of using the Internet every day for research became boring for some students and this format limited their interest in the Journey North project relative to other science units they had done that year. Participation in the activities also began to wane at the end of the five weeks, perhaps because students were getting bored and because it was the end of the school year.

- **In what ways, if any, do the girls in the classroom indicate that adolescence is a cultural initiation into femininity?**

As stated in the section on the science classroom, this question would best be addressed in a study that observed these girls in elementary and middle school. This question is mostly about change as suggested in the conceptual framework when long-term studies showed girls losing "voice" and assertiveness in their interactions with others. However, Sally in particular showed evidence of this orientation toward a lack of confidence in the computer lab as well as the science classroom. Her lack of confidence reflects the literature on adolescent girls' attitudes and actions that lead to a drop in achievement in school.

- **In what ways do girls enact feminine stereotypes in the computer lab?**
  - **In what ways do they resist these stereotypes?**

The girls in the class raised their hands quietly for longer periods of time in the computer lab than did the boys and therefore were more often overlooked by their teacher. This patience limited their ability to participate at times.

As in the science classroom, the girls in this study did not view themselves as experts in the computer lab. Instead, Sally and Hannah were open with their belief that boys were more adept at using computers because they were more experienced and knowledgeable. In contrast, Jenny did not make such a statement. She said she believed anyone could do well with computers if they tried hard enough.

Sally spent a lot of time flirting with Tommy in the computer lab; touching legs, shoulders and sitting close together. She was vocal about her disinterest and lack of knowledge about computers with her teacher and friends. Sally seemed determined to uphold her belief that she was not a computer person, as if it did not fit with her conceptualization of herself. Perhaps this had something to do with her notions about gender, though this was not addressed explicitly with her.

- **Does the notion that girls are motivated by human connection seem to hold true when the Internet is used in the science classroom for communication and collaboration?**

All of the focus students stated that they enjoyed using the Internet for communication and collaboration in this project. Tommy was actually the most excited about the email component of the project. He was also a very sociable person. This question is most interesting to address in light of Sally's experiences and beliefs about computers. Sally repeatedly expressed a lack of confidence and interest in using computers for tutoring and research. She found navigating the Internet and computer software complicated and frustrating. However, she was motivated to use email at home to communicate with a woman in Australia her father had met. Using the computer for communication seemed more accessible to her. So, in Sally's case, using the Internet for communication and collaboration might motivate her enough to increase her computer literacy if used over time.

- **What does the teacher say about gender differences in computer technology?**
  - **Does she observe any differences between groups of boys and girls in terms of participation, interest and learning?**
  - **What kinds of variations does she note?**

Laura observed boys to be viewed as experts in computer technology in her classroom. She viewed this in the class I observed and with a small group of students that met with her before school. She observed boys to be more eager users of the computer than girls, thereby indicating a difference in their participation and interest with computers. She did not comment about differences in learning nor did she note any variations to this pattern. It is notable that Laura had not used computers extensively with her students and that greater experience might provide more examples of student behavior to examine.

- **How do students view computer technology and the Internet with regard to gender?**
  - **Do students observe any differences between boys and girls in terms of participation, interest and learning in the use of computer technology?**

With the exception of Jenny, the participants in this study noted gender differences in student interests and expertise with computers. They believed that boys had more experience and knowledge about computers because they were more interested in using computers than girls. Hannah said that girls were better at making things and being fun, implying that girls had better things to do than become computer experts. Tommy said he thought girls were "slow" when it came to using computers. John said boys and girls just have very different interests. No one suggested these differences were related to learning or the ability to learn.

- **Are course materials gender biased?**

My review of the Journey North curriculum did not reveal any gender bias as suggested in the literature review. Both male and female role models were used in the project and the animal topics did not lend themselves to gender bias.

- **Is their teacher gender biased?**

As stated before, Laura made an effort not to be gender biased in her interactions with her students. That first day in the computer lab her time was dominated by boys, but after this was brought to her attention, she made efforts to distribute her time more equally. As a role model, Laura modeled to her students her willingness to learn about computers.

Section 3: The Novice

The purpose of this study was to examine how gender issues influence middle school students' participation, interest and learning when participating in an Internet-based science curriculum project. My research questions about learning were imbedded in my questions about gender.

- **Does the teacher observe any differences between groups of boys and girls in terms of participation, interest and learning?**
- **Do students observe any differences between boys and girls in terms of participation, interest and learning in science? In the use of computer technology? In the use of Internet technology?**

However, while data presented in the previous two sections show some ways in which gender issues shaped student participation and interest, I found that gender was not related to learning in this classroom. Instead, being a novice computer user was significant. Many students and the teacher were new to using computers and the Internet to the extent that was expected in the Journey North project. The fact that Laura was a novice became the most significant issue related to student learning in this study.

<u>The Novice Teacher</u>

As presented in the introduction, Laura was relatively new to teaching science and using computers. This was her first year teaching science though she had taught math for 10 years. She was also new to using computers with her whole class. Prior to undertaking this Journey North project, Laura had a basic level of experience with computers. She used a personal computer for word processing and used the Internet for email and researching lesson plans. In her interview, she described her experiences using computers at home and in the classroom.

Megan: So have you used the computer in your classroom or the lab previously?

Laura: Basically for stock market. And we've done quite a bit with, well we do a lot with stock market. Looked up stock quotes, we went in and got stock addresses because they write the stock companies and so we've gotten all the address. And we've strictly used it, though, for information. And it's not information we could get out of a library or anything like that. And then, not as much with my class as with my club, my stock market club, we go to the computer lab once a week and they get on and look up all different kinds of stocks. And the information, and the graphs, and all that information that they would get from that. And that has been basically all it's been limited to.

Megan: Is it an after-school club?

Laura: Before school. And then during math class, you know, if it's not in the newspaper then we'll come back and we'll get on it. But, our big thing is the computer in here is *so slow*, that sometimes it's just, you know, you can only do one or two because it takes forever. And that's really, and I think it's not having up-to-date equipment it's just like in the lab, that you know, that's a frustration. It's just a frustration you think, I mean gosh, how much wait time can I have?

Megan: So that's pretty much all you've done with the kids with this computer? And you didn't take your math classes to the big computer lab for stock market?

Laura: No, just the club.

Megan: How else do you use this computer for you?

Laura: Basically, I use my one at home all the time, I mean, because it's fast. I do all kinds of research, yeah, I do a lot of lesson plans on those, and on the money unit I've gotten tons off the computer. I check my email here, but on cards, business cards and everything I put my email at home just because it's so much faster. But I like that, and there's a math public, well PBS math uh, can't even think of the last part of it. Anyhow it's a PBS math Web site that I have gotten *a lot* of information from. But I get on it, I do it a lot with the computer, now that I have DSL. Before I didn't at all. I mean it was just such a waste of time.

Despite this knowledge, Laura became very frustrated and overwhelmed with the use of computers in the Journey North project. If she encountered a problem, she often did not have enough experience and confidence with computers to figure out a solution on her own. Laura's limited experience with computers became a significant source of stress for her in trying to organize and manage the project as it progressed. Her frustration and inexperience was evident to me from the beginning of the project. Before the project began, I ordered the curriculum for her and talked with her on the phone several times about it. The curriculum seemed very extensive and complex to her, as it might to anyone new to the project. My field notes capture her stress and how my role as researcher quickly became one also of assistant and educator.

> In the beginning stages of the project, I talked with Laura on the phone about once a week for four weeks before she began. She was nervous about enacting the project and overwhelmed with all it has to offer. She received the curriculum and I received a professional development packet and video. I thought I ordered the curriculum too. After reading through the printed curriculum, she was impressed with the project and all it has to offer but unsure about where to begin.
>
> After a couple of weeks of her thinking about it and finishing up another unit, I received a copy of the curriculum from her. Shortly thereafter, I went to the web site myself and explored what I thought she should do. I called her and told her what pieces to focus on and she really appreciated that. I suggested she follow the oriole migration since it comes through the area and the "ask the expert" date for the oriole wasn't until later in the spring. They had already missed the deadlines for several other species; the monarch being an option that would have also been locally interesting. I also suggested she contact another teacher to exchange data with so the kids could have the experience of meeting other kids in a distant location. The curriculum suggested several ideas for this data exchange and the teachers can also think of what works for them. About a week later, she told me she received a response from a teacher in Pennsylvania who teaches in a Mennonite community. Laura seemed excited about this prospect. I also suggested the kids go through the posting for the oriole on-line themselves to be able to explore the links and get the computer learning experience. We talked some about the logistics of managing kids in the computer lab such as putting a bookmark on all the computers for where the kids should go so they won't waste time typing in the web address and perhaps making mistakes. We also talked about her setting up an advance organizer or checklist for the kids to follow in the lab to help them stay on task. After she created her first one of these, she expressed concern it was too structured, but she would see how it went. Finally I suggested they follow some of the signs of spring activities that center around local spring events such as tree leaf out, tulips blooming,

frogs, etc. She said they had already gone outside and sketched a tree in the early stages of leaf out. They will do this again periodically until it is fully leafed out.

I think that a lot of her apprehension comes from worrying about doing the project in a way that benefits me the most. She doesn't want to disappoint me. Also, she has never done anything like this before and there is always that floundering when you are trying something new, especially if you feel it is a little beyond what you were ready for. She is definitely doing this as a favor to me and wouldn't have taken on the project, at least the Internet part of it, if I wasn't coming to collect data.

On Saturday before my arrival, I called Laura in the afternoon to check in and she was very stressed because she was trying to access the Journey North web site to create her lesson plans for the week. She had been unable to connect since 11 am – guessing the site was down. She was asking me what could be wrong and what she should do. I encouraged her that it would probably be back up soon and I would check on my computer after we got off the phone. I could tell she wanted help and we talked more about the logistics. At one point she said if this were a bust, it would be "my dog and pony show." I said that I wished I could write the lesson plans for her but didn't think that would work since she had to teach the lessons. She agreed. She is also responsible to the other two teachers on her team to develop the lessons for them to teach to the other classes. So there is a lot of pressure on her to make this work. It is hard since she isn't sure what to expect. I did check the web site right after we got off the phone and I got right on. I called her back and she said she had just gotten on too. She was relieved. I hope that I am offering her enough support to make her feel comfortable, I don't know how much more I can really do.

My role as assistant and educator for Laura continued when I arrived in town and spent each day in her science classroom. After my first two days in the class, it became apparent that Laura had structured the project as a research project only and that the students would not be participating in the collaborative and communicative aspects of the project. Without any help from me, the project would not have been enacted to a degree that would be sufficient to address my research questions. I pushed her to have her students write to the class in Pennsylvania, send in their answers to the challenge questions, post their local sightings of orioles, and use the postings from other participants in a data exchange activity. She was unsure about how to do these activities and was overloaded with work, so I drafted the lesson plans for her to present. These activities required that she set up email accounts for her students in the computer lab. This was something she had never done before. My journal entries illustrate the problems she encountered and how my presence shaped her participation in the project.

> Journal 5/10
> I talked with Laura on the phone tonight about the lesson planning. She said she spent about an hour in the computer lab after school trying to test how to send the challenge questions in before having the kids do it. She kept getting a message that it was undeliverable or server down or something along those lines. She was very frustrated. She tried it at home and it worked except she didn't get the message that said "your mail has been sent". She said she would be ready to bag it entirely if it wasn't for me. The computer teacher is gone on Thursdays so she didn't have anyone to help her. I volunteered to work with it tomorrow at school and come back if need be to meet with the computer teacher to figure it out. She is clearly frustrated. This is one of the biggest drawbacks to teachers having success with new technologies, the problems can easily outweigh the apparent benefits when they have to spend too much time and stress figuring it out on their own or running into glitches.

> Journal 5/11
> Today I spent the whole class period figuring out how to get an email account to work so the kids can exchange messages with another class and post their challenge question responses. Laura had spent an hour there after school yesterday and left completely frustrated with no success with the email program Pegasus. I arrived and the computer teacher was there today so I thought he could help me get it set up and straightened out. Well, as Laura mentioned, he was completely unhelpful. He was the only one there after the class left and he either didn't know how to do it, didn't understand the issue or is just an unfriendly guy. I ended up setting up a free email account on Netscape that then all the kids can input the same screen name and password so this will work.
>
> Talk about a barrier to teachers having success trying new technologies. If the experts who are supposed to assist them are either incompetent or territorial and unhelpful, teachers who are learning may be completely discouraged from pursuing their efforts. Laura was trying to input her Earthlink email address on Netscape thinking that would work, without having an understanding that you can't use servers from other programs like that. You have to set up a new

account with the server you are on. I don't even know if that's the right explanation, but I know that using an Earthlink account name wouldn't work on Netscape's email domain.

If I hadn't interceded at this point, Laura would not have pursued the email components of the project. She is too busy and demoralized to persist when there isn't enough at stake to continue trying. I will write up the directions and activity plans for the students to use next week in the lab, and may present them to the students instead of turning it over to Laura when she doesn't have a good grasp of how it all works and what needs to be done. This is where I cross over from the observer role to more of the participant-observer role. I am definitely influencing the direction of the classroom and by creating the lesson plans, changing the course of what would have transpired without me. But, I can't answer my research questions without taking these steps and maybe Laura will learn through watching and working with me so that she will be able to do such an activity confidently on her own in the future.

These experiences shed lots of light on the barriers to success in practical situations. Laura also has personal baggage with this computer teacher. They used to be teammates and she said it was such a horrible experience she wouldn't sign a contract for the next year unless she was guaranteed a new teammate. Sounds pretty bad. She told me that working with him is so difficult and because he is the only one, she has no choice but to "kiss his butt" to get what she wants. People like him can serve as gatekeepers to computer use since the lab is "his" room, where his desk, etc. is. Laura was surprisingly friendly and diplomatic with him given their history that I just learned. He is leaving after the end of this school year as he accepted a position outside the district. She said the whole district will probably be glad to see him go.

Laura repeated several times over the course of the project that she was "out of her comfort zone." Other examples of her lack of knowledge show that participating in this project was entirely new territory for her. For example, the day she was introducing the activity I created called "Using the Database" (see Appendix G), she asked the class if they thought gathering this kind of data was possible before the Internet. Some kids called out "yes," some called out "no." One boy shouted, "That's what phones are for!" Laura replied, "Good point." I was surprised that she affirmed this response and made it seem as if having people phone in their oriole sightings could yield the same quantity and quality of information available as quickly as was available on the Internet database.

Later that night, I spoke with her on the phone about lesson plans. She had received an email reply from David Aborn, the oriole expert from Journey North, to the three questions she had submitted from the class. She asked me how she could use this response. I suggested she forward it to the students' email accounts so they could read it for themselves. She stalled, so I suggested she forward the message to me and I would send it to the students. She then said she didn't know how to forward a message. Once I explained it to her, she caught on quickly.

In one final example, she mistakenly dismissed a girl's idea about using the Internet database.

> Laura: Okay, let's go on to number three. How would you go about finding out whether to believe the strange data or not? So if you answered number three. Michelle.
>
> Michelle: Track down the person who put in on the Internet.
>
> Laura: Track down the person who put in on the Internet? That might be a little difficult, but okay.

If Laura had been familiar with the database under discussion, she would have known that this was quite a good idea. Users can click on a posting and find out more detailed information about the person who posted the data, including an email address. It would be simple to contact the person and ask him or her more questions to decide whether to accept the data as valid.

Her lack of experience, along with the lack of support she received at her school became significant barriers to success for Laura. She even admitted at the end of the project that she did not want to put much effort into it.

> Megan: Why do you think you chose not to [have students post local data] initially?
>
> Laura: Because I'm on overload. I mean I'm really being serious. I was definitely, seriously, pretty well taking the easy, easy way out.

Without my intervention, she would have dropped out of the project or only completed the features that fit into her current style of teaching.

Intended Curriculum vs. Enacted Curriculum

Laura's status as a novice significantly affected the way the curriculum was organized and presented to students, and as a result, limited opportunities for student learning. Laura's lack of knowledge, time, and effort led her to avoid aspects of the project that were new to her, and even the lesson plans I created in these areas were not enacted by Laura in their entirety. As a result, Journey North in this classroom looked very different from what the developers intended.

As stated in the Journey North manual, the goal of the project is that students will use local and distant data to investigate patterns across the hemisphere that will shape their understanding of migrations and the arrival of spring.

> In this and other "Signs of Spring" activities, classrooms investigate the relationship between geography, temperature and the arrival of spring. Together students gather, organize and analyze their own data. Using the Internet, they can fit their local observations into a global context – essentially seeing that their small part of the world is part of a large, natural system. (Howard & Wiley, 2000, p. 2).

Laura did not plan to use the features of the project that would attain this goal, namely the collaborative and communicative aspects of the project. Instead, she conceptualized Journey North as a research project that students could complete individually. Despite my initial suggestions of what activities to complete that included communication and collaboration with local data, she decided that she would have the students research the oriole using the Journey North migration updates and have them write a research paper as the final project. She drafted daily activity sheets that guided them through what to do on the computer and what information to write down. After students completed one sheet, they moved on to another one without discussing the first activity in the classroom. This strategy left no opportunity for students to discuss with each other or with her about their learning. Laura graded their activity sheets but the lack of discussion left no other opportunities for her to correct or challenge students' thinking if they were off-track. The activities she selected and created also did not allow students any opportunities to examine local and nation-wide migration patterns. Without any time set aside for classroom discussions about activities already completed, students did not integrate the information they read on the Journey North site with any patterns whatsoever. This became apparent when I asked Laura to have the class work in small groups discussing the questions I had written on the lessons I created (see Appendix G). The following journal excerpt is about the small group discussion that I analyzed extensively in the previous section on gender differences in the science classroom.

> Well, I have an extensive critique of today's activities. Laura was going to not do the discussion questions that went along with the posting local data and mapping activities until I suggested that I really wanted to get some footage of the kids working in the classroom. In my opinion, the discussion questions were the central and key component of those lessons to make them meaningful and stretch kids to think about the activities. I had written on the teacher plans that she should have kids present at least one oriole and one leaf-out map (since they had a choice) so the kids could see the other ones. This didn't happen.
>
> So, today, she had them do the discussion questions for me. She ran off new copies of the questions from the activities and gave them to the groups devoid of the context in which they were intended. She did not even tell the kids to get their maps out to use when answering questions about patterns and outliers

in the data. So, the kids sat there and began to discuss questions that had no context, that they hadn't answered by themselves before, without the map that the questions referred to and were told how to do a structured group discussion activity. The five focus kids I observed started out bickering about the details of the group discussion more than the substance of the questions. After several minutes of debating and stalling because of the format problems, I interrupted and told them what to do. Then they proceeded. Perhaps other groups did not have this issue. Other groups were formed based on their cooperative seating groups that they selected, so most were with their friends.

The group I observed was extremely weak when it came to answering the questions. They didn't have much to say, didn't offer more than one idea, if that, and didn't push or question each other. They didn't seem to have enough background information about migration patterns in general and analyzing data to begin to respond to these questions appropriately. Given that this is the main point of the whole Journey North project, this is a big concern. But even on a more basic level, they didn't seem to select relevant points from the questions at times to focus on, especially in the scenarios. For example, Hannah and Sally didn't even consider the source of information as important, and they all focused on the exact number of monarchs (500) that a kindergartner reported saying that they couldn't have counted that many. They were so off on their points and logic that I was in disbelief. John had some good points, some of which the group listened to and some they discarded. At least the girls didn't defer to him entirely since he is considered a 'smart' boy in science. In their defense, the scenario questions were about monarchs, which they haven't studied and didn't have any background to know whether data were remotely possible or not and they didn't have much direction to set them up for this activity. That leads into the next big problem.

Laura doesn't appear to push the students' thinking and guide them to understanding the big picture, to draw conclusions from their activities or to be critical thinkers about their work. The kids were on their own to discuss questions, and when they presented their ideas to the whole class, Laura did not make any efforts to guide, correct or push their thinking. She accepted all answers, right or wrong, strong or weak as fine and good even when they weren't. She didn't say much at all except repeat their responses.

At the time I observed this activity, I felt highly critical of Laura's instruction and the quality of the students' work. While I still believe my critiques are valid, I have placed them in a broader context after analyzing the data. For example, after reviewing the data in a more systematic way, I realized that Laura failed to push students' thinking especially when she was pressed for time. At other times during the project, I did hear her challenge students' responses that did not make sense to think about whether their ideas were plausible. One example concerned the uniqueness of the Internet project.

> Laura: Can you think about this, think about the data that we have. Do you think if there were just scientists we would know all these sightings?
>
> Jake: No.
>
> Laura: No? Why?
>
> Jake: Cause scientists don't get out that much.
>
> Laura: Okay. Could they be at all these different places, Jake?
>
> Jake: Yeah they could.
>
> Laura: Are there enough scientists to be in all these different places, do you think?
>
> Jake: No.
>
> Laura: Okay, good point. I think you're absolutely right.

Reviewing the data thoroughly also revealed many effective teaching moments. For example, Laura was enthusiastic about the content she and her students were learning in the project. She was very excited when her students received email replies from the class in Pennsylvania and when she saw her students' postings on the Journey North database. Her outward enthusiasm seemed to motivate her students as well. She was quick to admit that she was learning along with her students. One day in the lab I heard her say to a student, "I don't know the answer to this one. We'll have to find out. So see, I don't have all the answers either!" She also circulated around the lab and probed students when they had questions to figure it out for themselves. She brought in a newspaper ad she found that advertised oriole feeders and shared it with the class.

However, from a broad perspective, the Journey North project was not enacted in this classroom to the degree it was intended by its developers. Since Laura was new to teaching science, using computers and the Journey North project, she was overwhelmed and turned the project into something that felt familiar to her – a research project. My presence pushed her to try new things and as to be expected, there was a learning curve she needed to progress through.

A Role Change

In addition to needing to learn more about computers and the Journey North curriculum, facilitating the use of computers with her students demanded a role change from Laura with which she was not entirely comfortable. She had experienced this role change previously with her stock market club when they switched from using newspapers to computers. She described herself as feeling left out and that she didn't know as much about what the kids were learning when they used computers. She felt that her role as classroom leader and discussion facilitator was eliminated in the computer lab.

> Laura: … I have to say, when I did, I used to do stock market club in here with the newspaper. And then we went over there, and stock market club in the computer lab, it's all right there, it's very quick, but their communication with me is not *near* what it was when they were over here.
>
> Megan: Why do you think that is?
>
> Laura: Well, I think it's, it's all right there, and it's pretty fast, and they send it in, and sometimes I wonder if they really stop and think about what they're doing. And so they don't ask questions, because it's just like this [snapping fingers]. And I don't know, but it's really interesting with stock market because I had done it both ways. Now as far as being efficient, it's probably

> much more efficient over there. But as far as actually them talking about and learning, you know, getting my knowledge, it's not there.
>
> Megan: So do they ask more questions when they were using the newspaper, or you....
>
> Laura: Uh huh. Many more questions.
>
> Megan: Like what kinds of questions?
>
> Laura: Oh, like questions about the stock, what do I know about the stock. You know, do you think that this is going to go up because of what is going on with the oil crisis, or....
>
> Megan: They would ask you this?
>
> Laura: Yeah, they would, you know, so there was a lot more collaboration as far as that part of it goes. But then I can stop and think about, okay, they can go in on a research site and they can research that on their own too. So maybe it's just me feeling left out. I mean, I don't know. I really don't.

Laura seems to believe that when students use computers for research they are "on their own" and don't need her to interpret anything for them or structure the same kinds of discussions about the content that she does when using newspapers or traditional materials. This was also the way she appeared to conceptualize her role in the Journey North project. As a result of my observations, I pushed Laura to think about ways she could integrate her ideas about herself as a classroom leader with the role change that comes with facilitating a project like Journey North.

> Laura: ...so there was a lot more collaboration [in the classroom] as far as that part of it goes. But then I can stop and think about, okay, they can go in on a research site and they can research that on their own too. So maybe it's just me feeling left out. I mean, I don't know. I really don't.
>
> Megan: Or is there a way you could create the same atmosphere?
>
> Laura: Yeah. I don't know. I mean, I really, I'm not sure. That's a good point. Because the computer is much more efficient for that.

Megan: Right. Is it because in the computer lab they work by themselves, and in here they're interacting more with each other, or....

Laura: Probably a little bit of both. I mean, you know, in the computer lab there's like, on a team, anywhere from three to five kids. And so they do talk that over, but you know there's always that dominant force that, you know, is the one that takes over. And I'm not really sure. But that was just an observation that I had made -

Megan: And you didn't really like that. I remember you said that before.

Laura: Yeah, no, I mean I really didn't. I really felt kind of left out, and I was like, and so maybe that is something I need to get over, I don't know. I really don't know. And it's even like on the orioles, until they come back and start, and you know, you talking to them, I'm sure *you* know more about what they've learned than I even do. And it's just kind of interesting because sometimes I think that piece isn't there that I would kind of like to have there.

Megan: Well, I wonder if there are ways you could take extra time to make it, you know....

Laura: I'm sure there are.

Megan: I wonder if it's just a matter of, making that part of it. You know, having more group discussions, coming back together, everyone talking, everyone coming to work on seeing the big picture, or posing questions. It seems there could be ways you could create that, you know, have them go and do their own little thing and then come back and....

Laura: Yeah, and I think it's probably something that, you know, the more I use it the more I'm going to get comfortable and I've got to figure out, I mean I have to figure out a way that I'm going to find, I mean I'm going to be able to make it all... [Megan: to make it do all those pieces]. But now stock market, the kids really like the computer better. They do.

Megan: Do they tell you why?

Laura: Well, it's so much faster. I mean they just, send in a trade, and then that trade goes in, well we did it by hand out of the newspaper, now they do like to look at the newspapers though, and they can get an overview of what it is, and we always take them in there. But what we did on the newspaper is that they filled out the newspaper, then we had to mail the little sheet in, and it was just, you know, I mean it was slow. Just slow. So, that's kind of something that I have to work through, I think, to make myself comfortable with it.

With practice, reflection and support, Laura might be able to overcome her hesitations and adapt to the changes that are required when participating in projects like Journey North. Based on my observations, this would be a necessary step for her to teach Journey North more fully and effectively. For this to happen, Laura would need to believe that the time and effort involved in learning would be worthwhile for her and her students.

What Laura Learned

At the end of the project Laura felt that she had learned a lot about computers, the Internet and Journey North. She was impressed with the project, even though she had only participated in a slice of it. She was excited about what she had learned about orioles and to a lesser extent, about computers.

> Megan: ..what have you learned? Is there anything else you want to add, what you learned from doing the project?
>
> Laura: Oh, [laughing] personally, I just learned a ton! I mean, I look for orioles, and as we were talking with the kids, I was not a bird-watcher. I was like, and I have to say, I think I started out, you know, saying that I think probably I was one of those, "You don't have anything else to do but watch birds?" [Laughter.] And I, my frustration is that I put out oranges and they never did come. [Megan: "Did you ever see one?"] No! No. And today when I asked the kids, probably three-fourths of the kids had seen them. And was there probably ten that had put out feeders?
>
> Megan: Yeah, I think there was nine that had put out feeders, and fourteen that had seen them or something.
>
> Laura: And I was just amazed that, you know, and all these kids are coming up and saying, "I saw this, and I saw that" or something, you know an oriole or even a different kind of bird. And another thing I would probably like to do is look at a different migration. I think that would be really interesting. I mean as far as me myself learning, you know, to follow a different one in the fall and in the spring. But I think it's been fun talking to the people in Pennsylvania, I mean the little bit that we've interacted with them.

> Megan: So you learned about birds. What else did you learn about? About computers?
>
> Laura: Oh I was going to say I learned a lot about computers. And I learned how to, I mean really how to get the kids set up and get them ready to go. And as I say, the first time I made that sheet, you know, the Day 1 sheet, and this kind of thing, I mean I had no idea. I had read a book on kids and computers and how you need to have, you know, if you are taking them to the lab you need to have enough to do and you have to have them focused. And I would definitely agree with the book. I mean you have to have a plan of where they're going.

Laura learned about the logistics of managing her students in the computer lab and also about the potential value of the Journey North project for student learning.

> Megan: … at first you didn't have the kids post any local data, and at the end we did. … Why do you think you chose not to do that?
>
> Laura: Because I'm on overload. I mean I'm really being serious. I was definitely, seriously, pretty well taking the easy, easy way out. And had we not done this, I wouldn't have realized the significance of the kids seeing their own data. I mean I really wouldn't. It was kind of like it was just another piece and I was moving on, and so, which I think, and that's why had we not done this I would not have explored all these avenues. And those are the things that really made this program work. [Megan: Oh, you think.] Yeah I do. Rather than just be a, you know, we got on the Internet, we did some research. But I think that them being able to, you know, to talk to, you know, Aborn, and to get their answers and then they're collaborating, they're looking, you know, they're talking to all these different people and that's just a piece that they wouldn't have had. I think about the number of kids that hadn't done email.
>
> Megan: Yeah, there were quite a few.
>
> Laura: So, I thought that was really kind of neat. Oh I do. And I think that the sightings, it's just like well Kurt came in yesterday and he came in late and he was going, "Look! Green Valley!" You know, and so here was like four or five of them….
>
> Megan: So he was excited about that?
>
> Laura: Yeah, even though it wasn't it.
>
> Megan: So you were glad that we ended up doing it?

> Laura: Oh I think it was really a valuable thing. I mean, I think it just took it from being a just a ho-hum thing to making it, you know, internalizing it and letting them see globally, and I'm still not sure they realize globally how big the whole thing is. I don't know. I mean I don't know. I don't know if you've gotten anything from them.
>
> Megan: John is the only one who really mentioned it. The global aspect of it. That that was unique or something. He didn't use that word, but, there's all these people, and he's the only one that brought that up. But, I didn't ask him that in particular. But most of them did questionnaires, and one of the questions on the questionnaire was, "Do you think that the Internet creates new opportunities for communication and collaboration that weren't possible before?" And most everyone said yes, or said I strongly agree, or I agree. No one said they disagree.

In this exchange during our interview at the end of the project, it became apparent that Laura began to understand the purpose of the Journey North project and how its opportunities for communication and collaboration could help students attain a more global perspective. She still didn't refer to the global perspective as being about migration patterns of the birds and animals under study, but a global perspective in terms of connecting with other people around the hemisphere who were also participating in the project. This indicates that Laura made some progress in learning about computers and the Journey North project. If she chose to participate again, she would undoubtedly do a better job of organizing and presenting the curriculum and in turn, provide greater opportunities for student learning.

Students as Novices

In concluding this section on the importance of being a novice, I will briefly discuss the ways in which I observed students to be novices and how limited experience related to student interest, participation and learning. Most of the students in this class had some basic experience using computers from keyboarding class and using the Internet for research had been mentioned in a library session. One female student recalled this information from the library, but no one else seemed to remember any details about it. Information from the whole class questionnaire indicated that 18 of the 21 students who responded had a computer at home. Only two students said Journey North was their first experience using the Internet and five said it was their first experience with email. My observations of the focus students indicated that they had not used the Internet and email enough to be able to use it independently at first in this classroom setting. Many others in the class also struggled based on Laura's frustration at the beginning of the project.

Of the five focus students, all but John had a computer at home. Hannah, Jenny, Sally and Tommy primarily used their family computers for typing reports and playing games. Only Sally used email at home with her father. Hannah's father tried to set up an email account for her but quit after having trouble because she was under thirteen. So, only Sally had used email before this project. Despite Sally's experience at home, she and all the other focus students needed to learn how to navigate the Netscape email program. In the computer lab, they all asked frequent questions such as "Do I click 'sign in' now?", "How do I send?", and "What now?" after they composed a message. From day to day, some of them had trouble remembering how to log in and retrieve messages. By the end of the project, they were more independent. In the interview Jenny admitted it was challenging to learn to use email.

> Jenny: Yeah I learned how to use the email and stuff. I never did that before.
>
> Megan: What did you think of that?
>
> Jenny: I thought it was sort of hard at first and then it gets easier after you log in and sign up on it.

Many students in the class experienced an array of problems such as getting lost in computer screens, typing email addresses wrong so they were returned, and losing a message because they didn't know how to send it or verify it had been sent. Lack of experience was frustrating for students. Laura had the class write a five-minute journal entry at the beginning of the project about what they liked and disliked about using the Internet to learn. Sally wrote

> What I like about the internet is its faster and you get great facts faster. What I don't like about the internet is I don't know how to use a computer so Im [sic] totally lost in the whole prosses [sic]. No I don't think this is a good way to learn because its [sic] hard and not that fun.

During the interview at the end of the project, Sally still wasn't comfortable with computers.

> Megan: Are there some things that you don't like about the Internet?
>
> Sally: I don't like how it, you have to go through several steps to get there. I think there should just be a button INTERNET and you just click on it and it just comes up and you're there. That's what I think.

She found it confusing to navigate the desktop icons and software prompts on the IBM format computer at school. Perhaps she would be more successful using the more user-friendly Macintosh interface as suggested by Turkle (1995) in the conceptual framework.

Interest

For Sally, her frustration with learning how to use the computer was a detriment to her interest in the project. It seemed that her lack of confidence and prior negative experiences with computers in elementary school shaped her "I'm not a computer person" identity. She participated in the project because she was a conscientious student and wanted to do well. She even worked on her research at home on the Journey North website. For the other focus students who overcame their initial frustration at being new to using email and the Internet, their lack of experience was not as significant a factor in their interest in the project. Hannah, John and Tommy all enjoyed the project and felt it was as interesting as all the other science units they enjoyed that year. Only Jenny and Sally said they preferred "hands-on" units to the Journey North project.

Participation

In general, it did not seem that students' participation was affected because they were novices. In the computer lab, they were on task when they were challenged by an activity and when they worked independently. All students completed their research paper on the oriole and turned in the worksheets on the migration updates Laura made for them. There was one day when John did not participate in the computer lab that was perhaps noteworthy. John always worked alone, unless he was forced to share his computer with someone. He usually worked quietly and steadily in the lab. One day though, I noticed that he did not have his mapping activity and sat there doing nothing. I brought this to Laura's attention and she confronted him. He said he left his work in the science classroom and she reprimanded him for not asking to go get it sooner, class was almost over. He said he would go to the library to use a computer that night to catch up. After school, I asked Laura about it and she said this happened one other time during the year. She contacted his mother and he quickly made up his work before school the next day. She said she was surprised though since he is usually one of the best and most attentive students in science class.

At the time, this situation caused me to wonder if his lack of experience with computers was a factor in his choice to not participate that day. John was obviously not excited about the activity or he would have quickly gone back for his materials so he could participate. I wondered if he was less motivated to learn in this Internet-based project than in more traditional science projects, and if so, if that reflected a difference in confidence in his abilities under each model. I attempted to explore this in my interview with him but his comments revealed that he was happy with the Journey North project and fascinated with all he had learned about orioles and the possibilities of the Internet. So, perhaps his lack of participation that day was a fluke. Or perhaps he felt that he needed to talk positively about the project in the interview and project himself as confident and competent even though he felt otherwise. As a result, I can only assume he spoke honestly and can't attach any significance to the incident in the lab.

Learning

The fact that these students were novices to computers and Journey North influenced their learning in that they spent some time floundering in the computer lab instead of being able to immediately focus on the content. The stress of being lost was a more significant distraction for Sally than for the others. Students who learned quickly and had confidence in their ability to learn the computer mechanics moved from floundering to focusing quickly and did not indicate that having to learn was a problem or a negative aspect of the project.

In fact, I believe that Laura's status as a novice was a more significant factor in student learning that the students' status as novices. If she had been more experienced, she could have delved more deeply into the project and helped the students make sense of all the pieces of information they were exposed to on the Journey North site. While students did not learn about the 'big picture' aspects of the project, they did learn a lot of details about the oriole from this project. In that sense, the research aspect of the project was effective. Each of the focus students could rattle off a list of things they learned.

Table 4.5: Student Learning

Student	**Quotes from interview regarding what they learned in the project**
Hannah	Well, I learned the orioles are east of the Rocky Mountains usually, and that they're neo-tropical, and they have wintering grounds and they have summering grounds, and their wintering grounds are when its winter in North America, during that time they're in like Puerto Rico I think. They eat fruits and nuts and seeds and nectar and jelly and stuff like that, and you could put out bird feeders, and during that time you could see them. And they like orange peels also, and the males are really pretty colors because they have like the black and the orange and the like, bar thingies. The females aren't very pretty. I mean, I don't think birds like making their females pretty, cause if you think about peacocks, the female peacocks are not pretty, the guys are.
Sally	Well I learned that there's two different kinds, the Bullock and the Baltimore. I learned that they're neo-tropical migrating birds. [Megan: "What does that mean?"] It means that they're here in the summer and then they go for the winter to a tropical place, or Costa Rica. The oriole, I don't know, I'm not sure when it mates, but it's like around May or April, or not April, but May or June somewhere around in there. There's more, I just…. [Megan: "Tell me one more thing."] The oriole when it flies it never knows, like if it hits a storm it has to go down, and so it's a grounding bird, so it just goes to the nearest land it can.
Jenny	I didn't know that an oriole ate oranges and had grape jelly and all that. And that it lived in that nest that that's bag-shaped and that in a book I read on it I didn't know it took the sugar water from other bird feeders. They eat from their own bird feeders and they take some from other ones. [Megan: Okay. Anything else?] Yeah, there's a lot. Like they're attracted to orange. Like if they see orange they'll go check it out when they're flying. And like…they're, let me think for a second. I didn't know that when the male, when it mates, when it tries to get a mate, that it whistles instead of guarding its territory. [Megan: What else?] That the oriole that sings, it hasn't mated yet.
John	I learned that at one time that the Bullock and the Baltimore were once called the Northern Oriole, just both of them, and that now scientists have classified them as two different orioles. I learned a lot about their feeding habits, about gaping, and the food that they eat.
Tommy	I've learned that, because I wasn't paying attention from last year, but this year I've been paying attention a lot. Like, birds migrate during the winter and stuff, and the birds in the spring, that's when they kind of lay their eggs. Yeah, when I was down at the lake, the orioles were flying around, I think that's because it was the first part

	of spring. That's what they were doing I think. I really don't pay attention, but now I'm starting to. I'll say, "Hey! That's an oriole!"

As suggested before, the students learned many details about the oriole, but not about how their patterns of migration relate to climate change, weather, and the progression of spring throughout the country. The students all seemed to enjoy what they learned about the oriole, so the project was meaningful to them even without delving more deeply into the aspects of the project they missed.

Summary of Research Questions Addressed in Section 3: The Novice

During my conceptualization of the project, I did not include a specific research question about student learning because I did not intend to measure student learning in a quantifiable way. Instead, I intended to address student learning anecdotally and in conjunction with participation and interest in science and computer activities. As a result of this approach and the gender focus of this study, I embedded the question of student learning within my research questions about gender:

- **Does the teacher observe any differences between groups of boys and girls in terms of participation, interest and learning?**
- **Do students observe any differences between boys and girls in terms of participation, interest and learning in science? In the use of computer technology? In the use of Internet technology?**

As I mentioned at the beginning of this section, I found that gender was not significantly related to student learning. While differences in participation and interest in science and computer activities between boys and girls seem to imply a potential difference in learning, I could not measure this in my study. Instead, a much more obvious and significant factor was the inexperience of the students and the teacher with the Internet and computer technology expected of them in this project.

The fact that Laura was new to teaching science, the Journey North project and using computers with her class was the most important factor in determining the types of experiences the students had with the project. As a novice in all of these areas, Laura was overwhelmed and "out of her comfort zone." As a result, she was unable to enact the project in ways that were new to her and unable to understand the scope of the project with the limited amount of time she devoted to it. Instead, she focused on the particulars of getting through each day, such as drafting guidelines for the students to follow in the computer lab, figuring out how to set up email accounts, teaching her students how to post email, and planning for the next day. She did not have time to reflect and contemplate the "big picture" of the project, and therefore she could not help her students make sense of all the pieces they were learning.

As a result, the students did not learn about migration patterns, collecting and sharing local data, or how weather and geography interact each year in unique ways that influence animals' migration. Instead they learned many details about the oriole and about using the Internet and email. These were the same things that Laura learned. This was a valuable first step for Laura if she would decide to pursue participation in an Internet-based science project in the future. Likewise, her students enjoyed their learning experience and will likely be able to apply what they learned about computer technology in future endeavors. Undoubtedly, data on student learning would look very different if this study were conducted in Laura's class after she had several years' experience teaching science and participating in Journey North.

CHAPTER 5: DISCUSSION

Introduction

The purpose of this chapter is to summarize the main conclusions from this study and to discuss their significance and implications for professional development, curriculum development, teacher and students. This chapter also presents the limitations of this study and questions for further research.

Conclusions and Significance

The main conclusions from this study are:

- **Boys were viewed as science and computer experts by themselves and by their peers more often than girls, both when they were and were not more knowledgeable.**
- **The teacher's inexperience with computers and the Journey North project was a significant factor in student learning.**
- **The use of the Internet for communication and collaboration may have potential to encourage greater participation in computer technology with students previously disengaged.**

This section presents examples from the research findings that support each conclusion and discusses the significance of each conclusion for science education research.

- **Boys were viewed as science and computer experts by themselves and by their peers more often than girls, both when they were and were not more knowledgeable.**

Findings in the both the science classroom and computer lab settings support this conclusion. For example, in the science classroom, boys participated more regularly and more assertively than girls in terms of volunteering answers, sitting near the front of the room and taking leadership roles in small group work. One male focus student, John, was more vocal about his knowledge of science topics than most students in the class and was deferred to as an "expert" by the teacher and classmates in large and small groups. Tommy, the other male focus student, was not as knowledgeable about science topics as John, yet in a small group setting, exerted himself as a leader and potential "expert" more often than the girls. In the computer lab, some students asked boys for help more often than girls, and expressed beliefs that boys are more knowledgeable and interested in computer technology than girls. In both settings, some students assumed that boys were more knowledgeable than girls even when I observed this not to be the case.

The notion that boys are viewed as experts more often than girls is **significant** in that it supports prior research on the gender gap in science and computer technology reviewed in the conceptual framework for this study. By and large, participants in this study viewed science and computer technology as masculine domains. As a result, girls' participation and interest in Journey North trailed boys'. However, findings from this research did not indicate that girls' learning suffered as a result of their views of science and computer technology as masculine domains.

- **The teacher's inexperience with computers and the Journey North project was a significant factor in student learning.**

Research results indicated that student learning was more influenced by the experience level of the teacher than by gender differences in science and the use of computer technology. This finding was not anticipated when designing the study and thus was not reflected in it conceptualization. However, data collection and analysis revealed that issues related to being a novice had important implications for students' experiences and learning with the curriculum. Therefore, this conclusion is important to address as it contributes to literature regarding the incorporation of new computer technologies into the science classroom.

In this classroom, many students and the teacher were new to using computers and the Internet to the extent that was expected in the Journey North project. Students who were confident in their ability to learn how to use the technology quickly learned how to navigate the computer interface, the Journey North website, and email. The teacher was overwhelmed and "out of her comfort zone" with the demands of enacting Journey North for the first time. As a result, she did not attempt features of the project on her own that were new to her and could not devote time to understanding the "big picture" of the project. Therefore, students did not learn about the "big picture" of the project either but instead learned many details about the oriole from their research.

The conclusion that student learning was most influenced by the experience level of the teacher is **significant** in that it contributes to recent literature that explores the central role teachers play in the effective enactment of network science projects. Some of this literature is discussed in the implications for professional development section following this presentation of conclusions.

- **The use of the Internet for communication and collaboration may have potential to encourage greater participation in computer technology with students previously disengaged.**

This conclusion is supported by the case of Sally, and to a lesser extent, Tommy. In this study, Sally was the least interested in computer technology of all the participants. She maintained a negative and tentative attitude toward using computers and the Internet throughout the project. Sally seemed determined to maintain an image of herself as "not a computer person." However, in the interview, Sally said that participating in Journey North had gotten her into the Internet. Additionally, she discussed a positive experience using email at home to communicate with a woman in Australia. She described using email as uncomplicated whereas all her other experiences with computers she viewed as complicated and frustrating.

It is possible that continued use of computers for communication and collaboration might increase Sally's interest and participation with computer technology. Data revealed that using computers for communication did spark her interest and participation with computer technology at home, and to a lesser extent, at school. However, Sally has such an engrained negative view of computers, it is not likely she will pursue computer use beyond using it for communication.

Finally, the case of Tommy contributes to the discussion of this conclusion as well. Tommy was a poor student yet highly sociable. Tommy indicated that he viewed science and computer technology as masculine domains in his actions and statements in the interview. Because Tommy demonstrates some confidence in these areas and views them as appropriate for him, he is even more likely than Sally to benefit from the use of computers for communication and collaboration in science. Tommy was highly motivated by the idea of using email in this project, and if the project had been enacted more fully, I think he would have also been motivated by the opportunities for collaboration. His increased interest positively affected his participation.

In sum, I would argue that the use of the Internet for communication and collaboration might spark the interest and participation of students like Sally, who are normally disengaged with computers, and like Tommy, who lack motivation. Whether the incorporation of collaborative Internet projects into the science curriculum may also provide new opportunities for students to become engaged with science cannot be concluded from this study, especially because all participants liked science. Also in this study, the use of computer technology for communication and collaboration did not affect students' perceptions of science and computer technology as masculine domains. Therefore, increased engagement may help some students want to learn, but will not likely change views of science or computing as masculine. As a result, girls who maintain views of these fields along gender lines will most likely opt out of pursuing them as suggested in the conceptual framework.

The conclusion that the use of the Internet for communication and collaboration may have potential to encourage greater participation in computer technology with students previously disengaged is **significant** in that it begins to explore some new questions with regard to gender differences and educational technology. Results from this study support the idea that the combination of science and computing as masculine domains may perpetuate the gender gap in these fields. Results also suggest that the use of the Internet for communication and collaboration is significantly different and more engaging to some users than traditional computer technology. Whether this more engaging use of technology in science could entice more girls into the world of computer technology or science, or alter the perception of computing and science as masculine *over time* remains to be seen.

Implications

The conclusions from this study have several implications to consider in light of science education research. Implications for professional development, curriculum development, teachers and students are discussed in this section.

Implications for Professional Development

> One of the things that I think educators...you know, because I have really had a lot of professional development. I've had no professional development along this line whatsoever. And this is one area, it's here, and this is one area for educators that I think we're going to have to do something with. ... There are not too many schools out there that are doing that much with this program. Computer in the classroom many times, is kids go to the lab, they play games, you know, they do the tutorial typing, and we're missing the boat (Laura, personal interview, p. 34).

At the end of Laura's interview, she volunteered the previous comment about her lack of professional development with regard to computer and Internet technology. She lamented that she had not had more education in this area and that even with her travels around her state and interactions with other teachers, she had not seen anyone else participating in projects like this. While her comment illustrates the limited number of classrooms in which Internet-based science projects are being utilized, it also illustrates that the use of the Internet in the classroom has not made it into the mainstream set of topics for teacher educators, at least in her state. This is notable in light of the fact that there has been such a national push to connect all classrooms to the Internet and that this has by and large been completed (Johnston, 2001). Laura's experience highlights the notion that we are rushing ahead with the assumption that Internet access will benefit students, without regard to why and how. This study suggests that students may benefit, especially under the guidance of a knowledgeable and experienced teacher.

The Role of Teachers. After writing Chapter 4, I read some recent publications reviewing the effectiveness of the use of computer and network technology in classrooms. Two books in particular, *Network Science: A Decade Later* (Feldman et al, 2000) and *The Digital Classroom* (Gordon (Ed), 2000), extensively explored the central role teachers have in realizing the potential of network science projects. These books noted how the role of the teacher had been largely ignored in the conceptualization and development of early network science projects. This struck a chord with me because their conclusions reflected Laura's significance in this study and my limited attention to her potential role in the conceptual framework.

The authors of these books noted that Internet-based science projects embrace a constructivist learning theory that is new to many teachers. These projects are created under the assumption that inquiry-based learning is the most effective and desirable foundation for science curriculum. While many science teachers are familiar with hands-on science experiments in which students manipulate materials to understand scientific concepts, oftentimes these experiments do not allow students to formulate and test their own hypotheses or investigate phenomena in which the outcome is not predetermined. Network science projects seek to have students act like scientists in that they gather local data, share and interpret this data with others in distant locations in a real-time situation. These data are also intended to be useful to scientists who, on their own, could not collect the quantity of data that students across the country can.

The researchers found, among other things, that teachers not only have to learn to use new technologies, but they also need to learn new content and pedagogies to help students get the most out of these projects. In the forward *to Network Science: A Decade Later*, Barbara Means writes that

> Technology proponents have suggested that we need to transform teachers into proficient users of Internet resources and tools. The experience of network science projects suggests that comfort with technology tools per se may be much less an issue than comfort with the subject matter and data analysis at the heart of network science projects. Teaching teachers to use Internet browsers and spreadsheet software will not be enough: we need to make sure that they understand the science, the kinds of questions that can be addressed with data, and the analytic techniques that can address those questions with data. Moreover, teachers need to be able to make these difficult concepts accessible to their students (Feldman et al, 2000, p. xi).

Professional development for teachers has been lacking in the first decade of network science projects, the results of which have become apparent to researchers. Feldman et al (2000) write that the role of the teacher was not given much consideration in the original visions of network science and that now, they realize how central professional development for teachers is to the success of these projects.

My experience with Laura as a teacher who was new to both science and computers highlights the importance of these research findings. We cannot expect to throw teachers into curricula that employ technologies and pedagogies that are new to them without expecting them to flail, drop out or adapt curricula in ways already familiar to them. While network science projects may offer learning experiences that can be highly engaging for students and offer unique experiences with data collection and analysis, these learning opportunities will most likely not be realized in a classroom where the teacher has no prior experience or professional development specific to the project.

Time to Learn. Expecting ample time for change is another important reality along these lines. My presence in Laura's classroom pushed her to try the project and implement features totally new to her within a matter of weeks. I was frustrated when she didn't enact the local data collection, communication and collaboration features of the project. What I failed to appreciate was how unrealistic my expectations were. I have had experience studying network science projects and working as a curriculum developer and researcher on the Kids as Global Scientists project when it was directed here at the University of Colorado. Graduate coursework in science education has helped me understand and value the pedagogies at work in the Journey North project and provided a context in which to reflect upon my years teaching middle school science. Instead of expecting change within a matter of weeks or months, it may take several years for teachers to fully enact new Internet-based projects in the classroom.

An elementary school teacher who uses the Journey North project chronicled her progress incorporating the Internet feature of the project into her classroom in the book *Network Science: A Decade Later.*

> Teacher Susan Wheelwright was already doing similar ecology investigations when she learned about Journey North from a parent of one of her students. Despite her comfort with the project's pedagogy and content, she gave herself 3 years to fully incorporate the project's technology components. "When I learned that first year that I could be doing all [of] this on the Web, I said, 'No way, I couldn't take that all in. I'll just do it through e-mail,' which was also new to me." The second year, she accessed the Web through the library computer, where she could count on the support of nearby staff. It was only in the third year that she began using the Internet connection in her classroom (p. 71, Feldman et al, 2000).

This story helps establish a realistic learning curve for teachers with no professional development within their district or from project staff. Perhaps implementation could come sooner with effective professional development, but nonetheless, it still takes time to become comfortable and confident with new ideas and practices.

Implications for Curriculum Development

Teacher support. Building on the implications discussed for professional development, curriculum developers need to take into account the time and education required for teachers to learn to teach these projects effectively. More opportunities for teacher learning should be built into curricula to help teachers contemplate solutions to everyday problems they may encounter (e.g. how to set up email accounts, how to maximize student participation if they need to share computers, etc.) Furthermore, on-line support from project developers is very important and surely helpful to many participants. Laura did not utilize any such features of the Journey North project since I played the role of consultant for her. Even with my presence and participation, Laura was frustrated and overwhelmed. Therefore, many teachers can be expected to avoid attempting a project like this and to drop out if they do try and experience many frustrations. Addressing this learning curve explicitly would be helpful and perhaps would make teachers feel normal and more willing to persist. Teacher to teacher discussion forums like the one on Journey North provide opportunities for teachers to connect and discuss project ideas, but additional direct attention to this by curriculum developers might be helpful.

The Gender Gap. In terms of addressing the gender gap in science and computer technology, curriculum developers also need to address this explicitly. Data from this study suggest that creating engaging curriculum that encourages greater participation and interest by students normally disengaged is not enough to change perceptions of science and computer technology as masculine domains. If curriculum developers have an agenda to increase the participation of a wider variety of students in science, breaking down the engrained perceptions of science and computers as masculine will have to be addressed with students.

Implications for Teachers

The Gender Gap. Similarly, teachers who wish to close the gender gap in science and computing will need to address student and societal perceptions of masculinity and femininity directly with students. Teachers who are knowledgeable in this area have more opportunities than curriculum developers to have a significant impact on students' perceptions because of their relationship with students and time spent with them. Curricula that educate teachers about gender issues are central to providing teachers with knowledge and ideas about how to go about changing student attitudes, but the power lies with teachers to influence students in meaningful ways.

Student Achievement. Likewise, teachers have powerful opportunities to shape students' attitudes toward subject matter and technologies. In Sally's case, her elementary school experiences with computer technology were stressful and felt punitive to her. She developed a lingering sense of inadequacy with them, perhaps based on these negative experiences. Oppositely, Tommy indicated he was trying harder this year in school because he liked his teacher and had more confidence that he could stay out of trouble. Laura's efforts to maintain a positive and enthusiastic atmosphere in science class positively affected Tommy's interest and participation, and probably learning. These examples reflect the implication that teachers have great power to determine students' interest and achievement and should make every effort to use their influence in positive ways.

Time to Learn. Good teachers need time to become good at teaching in new ways and with new technologies. If teachers believe the effort required to learn new methodologies and technologies will benefit students in the long run, they should give themselves ample time to do so. They should start small by integrating parts of projects that feel feasible and continue to add features of projects over time. Journey North is especially attractive in this respect as it allows teachers maximum flexibility to pick and choose how much to do over the course of a year.

Implications for Students

Results from this study suggest that students' beliefs about their own abilities and interests shape their participation and interest in subject matter. Students with prior negative experiences and attitudes toward particular subject matter are likely to harbor low self-confidence which, in turn, may limit their participation and interest in that area. This was the case with Sally. Teachers and parents are in roles to help students identify these self-fulfilling prophecies and to help them make conscious choices about their interests. Ultimately, however, adolescents will have to make these choices themselves.

Limitations of the Study

As with any type of research, there are limitations in the ability of the methodology used in this study to adequately account for all of the issues that play a role in the phenomena observed in the research setting. Qualitative methods are messy by nature; the researcher is involved in the setting and makes subjective interpretations and evaluations of the relative importance of observed phenomena as discussed in chapter three. Examining complex issues with small numbers of participants limits the generalizability of results. Instead, qualitative research provides information that one could not get from large-scale, generalizable random sampling.

Further limitations of the study include that I was only in the classroom for five weeks. I was not able to chronicle the experiences of these students over the course of a whole year with one teacher, or over multiple years. This short time frame left me unable to address the question of whether the girls in this study are experiencing a change in their actions and interactions that might be related to the pressures of adolescence. I could only relate their actions and interactions in this regard to ideas presented in the literature review.

There are also subtle issues that relate to the limitations of this study, such as the examination of gender differences with small numbers of students. I realize that discussions of gender differences as reviewed in the conceptual framework refer to populations of people, not individuals. Most certainly, individual girls vary tremendously as do individual boys. One can find girls who comfortably exhibit many traditionally "masculine" qualities and boys who excel at things traditionally considered "feminine." This complexity was very evident in my study with these five students.

Upon reviews from some committee members and based on my own struggle to organize the vast amount I data I collected, I realized that I set out to address too many research questions. Perhaps the study would be stronger if more focused. In retrospect, I realize that I identified all these research questions because they fell out of the literature review. I felt that I had to have a research question for every issue I addressed in the conceptual framework. I would have been better off to ask fewer, open-ended research questions. All in all, a qualitative dissertation study can get overwhelmingly large and complex. While I did omit some data I analyzed from my findings chapters, I found it difficult to leave out data I worked so hard to analyze and fit into my thematic framework.

Questions for Further Research

At the conclusion of this study, I am left wondering where I would go from here if I had the time, or what I would do differently if I could go back. I have identified a few questions that would be interesting to examine in light of the questions this study could not address.

- **What kinds of changes would occur in Laura's classroom if she taught science with Journey North over the course of several more years?**

Studying Laura's enactment of Journey North over time would help examine the learning curve required for teachers to learn to implement new technologies and pedagogies in science education.

- **What kinds of changes would occur with each focus student over the course of several more years, before or after this snapshot in time?**

Following these students would help address whether gender issues unique to adolescence have brought or will bring significant changes to their confidence levels and participation, interest and learning in science and with computer technology.

- **Does addressing the gender gap in science and computer technology explicitly with students change students' perceptions of their abilities in these fields?**

Since this study does not suggest that the use of computer technology for communication and collaboration alone will reduce the gender gap in science, I would like to study what will. This is one avenue to explore.

- **How would the results of this study look different in a classroom in which the students and the teacher used the Internet for communication and collaboration adeptly and over a long period of time?**

Studying experienced participants would also help address whether using the Internet for communication and collaboration more fully might yield different results regarding its power to alter perceptions of computer technology and/or science as masculine.

- **How do theoretical frameworks that examine the role of teachers and the learning required to incorporate new technologies in the science classroom further inform the results from this study?**

Since the conceptual framework for this study did not include research on teacher learning, an examination of the literature would offer additional avenues to explore related to Laura's first time experience with Journey North.

Conclusion

In conclusion, findings from this study support prior literatures that document a gender gap in the fields of science and computer technology. The findings also suggest that the use of the Internet for communication and collaboration is more appealing to a wider audience of students than traditional uses of computer technology. However, results from this study are unable to suggest that increased engagement in computer technology in science class will break down the image of science or computing as masculine domains. The participants' lack of experience with computer technology and their limited participation in Journey North, though, begs the question as to whether results would be different in another setting. Ways in which the appeal of using the Internet for communication and collaboration can help achieve the goal of "science for all" merits further research.

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Appendix A

Whole Class Questionnaire

Are you male or female? M/F (circle one)

Directions: Circle the number that best represents whether you agree or disagree with each statement according to the following scale:

1= strongly disagree **3= neither agree nor disagree** **5= strongly agree**

I like science.

1 2 3 4 5

I enjoy using computer technology other than the Internet (i.e. making presentations, word processing, games, paint or draw programs, etc.)

1 2 3 4 5

I enjoy using the Internet.

1 2 3 4 5

I enjoy using email.

1 2 3 4 5

I like using the Internet and email more than using other types of computer technology.

1 2 3 4 5

I like using other types of computer technology more than the Internet or email.

1 2 3 4 5

Anyone who likes using computers would also like using the Internet or email.

1 2 3 4 5

Anyone who likes using the Internet or email would also like using other types of computer technology.

1 2 3 4 5

1= strongly disagree **3= neither agree nor disagree** **5= strongly agree**

Girls and boys are equally talented in science.

1 2 3 4 5

Girls and boys are equally talented at using computer technology.

1 2 3 4 5

My science teacher thinks boys are girls are equally talented in science.

1 2 3 4 5

My science teacher thinks boys and girls are equally talented in using computer technology.

1 2 3 4 5

My science teacher seems to favor girls over boys (call on them more often, interact with them more, or like them better).

1 2 3 4 5

My science teacher seems to favor boys over girls (call on them more often, interact with them more, or like them better).

1 2 3 4 5

In my science classroom, boys and girls participate equally when working together in small groups.

1 2 3 4 5

In the computer lab, boys and girls participate equally when working together in small groups.

1 2 3 4 5

Some students think girls are not supposed to like science.

1 2 3 4 5

Some students think girls are not supposed to do well in science.

1 2 3 4 5

1= strongly disagree **3= neither agree nor disagree** **5= strongly agree**

Some students think girls are not supposed to like computers.

1 2 3 4 5

Some students think girls are not supposed to know a lot about using computers.

1 2 3 4 5

In my science class, our course materials (like textbooks) make it seem like men are better at science than women.

1 2 3 4 5

Course materials for computers make it seem like men are better at computers than women.

1 2 3 4 5

TALLY SHEET

Journey North Questionnaire

Circle one answer for each of the following questions. Totals

21

Are you male or female?
Male 111111111 9
Female 111111111111 12

Do you have a computer at home?
Yes FMFmffmmffffmfmfm overall - 18 M. 7 F. 11
No mfM overall 3 M-2 F-1

Journey North has been my first experience using computers.
Yes 0 0 0
No FMmFmfffmmfmfffmfmfm 21 9 12

Journey North has been my first experience using the Internet.
Yes Mf 2 1 1
No FmFMffmmfmffffmfmfm 19 8 11

Journey North has been my first experience using email.
Yes MmFff 5 2 3
No Ffmfmmfmfffmfmfm 16 7 9

Answer the following questions in the space provided.

What did you like about the Journey North project?
Computers Ff
Internet mffm
Email mff
Lots of info MM
being focus st. F
learn about Oriole MfMM
fun M
uptodate M
going outside M
nothing M
research ff
Watching tree bud - ff

What did you dislike?
Maps FM
boring F
slow comp. mffm
too many paragraphs f
the report MM
unable to choose own animal f
everything Mf
not enough time f
folders f
nothing m
research fm

List at least three things you learned during this project.
Oriole details FMMfmfffmmfmfffmfmfm
How to use Web f
Find info on line f
Hard to find info on line M
Takes time to do a good project M

Circle the number that best represents whether you agree or disagree with each statement according to the following scale:

1= strongly disagree **3= neither agree nor disagree** **5= strongly agree**

I like science.

I like science.

				Overall	M	F
disagree	2	1		0	0	0
		2	mf	2	1	1
		3	Ffffm	5	1	4
agree	14	4	Mmmmffmf	7	4	3
		5	fffMmfm	7	3	4

I am good at science.

			Overall	M	F
5	1		0	0	0
	2	Ffmff	5	1	4
	3	ff	2	0	2
14	4	Mmmfffmmfm	10	6	4
	5	ffmm	4	2	2

I enjoy using computer technology other than the Internet (i.e. making presentations, word processing, games, paint or draw programs, etc.)

			Overall	M	F
1	1		0	0	0
	2	f	1	0	1
	3	fm	2	1	1
17	4	mmffmfff	8	3	5
	5	FMfmffmmm	9	5	4
		don't understand - f			

I enjoy using the Internet.

			Overall	M	F
1	1		0	0	0
	2	m	1	1	0
	3	ffff	4	0	4
16	4	mmmmff	6	4	2
	5	FMmfffffmm	10	4	6

I enjoy using email.

			Overall	M	F
0	1		0	0	0
	2		0	0	0
	3	mmmmffm	6	4	2
15	4	Fmfmf	5	2	3
	5	mffffffmfm	10	3	7

I like using the Internet and email more than using other types of computer technology.

			Overall	M	F
4	1		0	0	0
	2	fmfm	4	2	2
	3	Fmmffmfmm	9	5	4
8	4	mf	2	1	1
	5	mfffff	6	1	5

I like using other types of computer technology more than the Internet or email.

I like using other types of comp techn. more than Internet or email

				overall	m	f
7	1	ffffmm	1	6	2	4
	2	m	2	1	1	0
	3	Fmmfffm	3	7	3	4
7	4	mff	4	3	1	2
	5	mmff	5	4	2	2

Anyone who likes using computers would also like using the Internet or email.

				overall	m	f
2	1	m	1	1	1	0
	2	F	2	1	0	1
	3	fmmfffmmm	3	9	5	4
10	4	mmff	4	4	2	2
	5	fffmff	5	6	1	5

Anyone who likes using the Internet or email would also like using other types of computer technology.

				overall	m	f
4	1	Ff	1	2	0	2
	2	fm	2	2	1	1
	3	mfmfffmm	3	8	4	4
9	4	mmmf	4	4	3	1
	5	mffff	5	5	1	4

I have used a computer in school many times before this project.

				overall	m	f
5	1	f	1	1	0	1
	2	Ffff	2	4	0	4
	3	Mff	3	3	1	2
13	4	mffmf	4	5	2	3
	5	mffmmmmm	5	8	6	2

I use email frequently at home or at school.

				overall	m	f
8	1	mfmfmm	1	6	4	2
	2	ff	2	2	0	2
	3	fmfmf	3	5	2	3
8	4	Mff	4	3	1	2
	5	Ffmfm	5	5	2	3

I use the Internet at home or at school frequently.

				overall	m	f
3	1	m	1	1	1	0
	2	mf	2	2	1	1
	3	mff	3	3	1	2
15	4	mfffmfff	4	8	2	6
	5	Ffmmfmm	5	7	4	3

I use the computer in my classroom during my free time.

Comp in class during free time

		Scale	Responses	Overall	M	F
disagree	13	1	Fffmffffmfmf	12	3	9
		2	f	1	0	1
		3	mf	2	1	1
agree	6	4	mfmmm	5	4	1
		5	m	1	1	0

The Internet creates new opportunities for communication and collaboration (working with others) that weren't possible before its invention.

	Scale	Responses	Overall	M	F
1	1		0	0	0
	2	f	1	0	1
	3	fmff	4	1	3
16	4	FMmmmffmf	8	4	4
	5	mffmffmm	8	4	4

I think girls and boys are equally talented in science.

	Scale	Responses	Overall	M	F
4	1	mf	2	1	1
	2	ff	2	0	2
	3	ffmm	4	2	2
13	4	mmmffmm	7	5	2
	5	Fmffff	6	1	5

I think girls and boys are equally talented at using computer technology.

	Scale	Responses	Overall	M	F
4	1	mfff	4	1	3
	2		0	0	0
	3	fmfm	4	2	2
13	4	mmfmm	5	4	1
	5	FMfffmff	8	2	6

Ms. Crain thinks boys are girls are equally talented in science.

	Scale	Responses	Overall	M	F
1	1	m	1	1	0
	2		0	0	0
	3	mfmffff	7	2	5
	4	Mfm	3	2	1
12	5	Fmffffmffm	9	3	6
	no response	m			

Ms. Crain thinks boys and girls are equally talented in using computer technology.

	Scale	Responses	Overall	M	F
0	1		0	0	0
	2		0	0	0
	3	mmmffff	7	3	4
14	4	mffmm	5	3	2
	5	Fmfffmffm	9	3	6

In my science classroom, boys and girls participate equally when working together in small groups.

				Overall	M	F
5 <	1	mf	1	2	1	1
	2	fff	2	3	0	3
	3	mff	3	3	1	2
13 <	4	Fmfmf	4	5	2	3
	5	mfffmmmmm	5	8	5	3

Some students think girls are not supposed to like science.

				Overall	M	F
10 <	1	ffmfm	1	5	2	3
	2	mffff	2	5	1	4
	3	FfMfm	3	5	2	3
6 <	4	mf	4	2	1	1
	5	mmfm	5	4	3	1

Some students think girls are not supposed to do well in science.

				Overall	M	F
12 <	1	ffmffmm	1	7	3	4
	2	mfmff	2	5	2	3
	3	Fmm	3	3	2	1
5 <	4	f	4	1	0	1
	5	mmff	5	4	2	2
	no response	f				

Some students think girls are not supposed to like computers.

				Overall	M	F
15 <	1	Ffffmfmm	1	8	3	5
	2	mfmffffm	2	7	3	4
	3	m	3	1	1	0
5 <	4	mfff	4	4	1	3
	5	m	5	1	1	0

Some students think girls are not supposed to know a lot about using computers.

				Overall	M	F
14 <	1	Ffmmfmffmm	1	10	5	5
	2	mffm	2	4	2	2
	3	fmff	3	4	1	3
3 <	4	f	4	1	0	1
	5	mf	5	2	1	1

Do you have any other comments about the project?

Loved using the internet - F

Good learning experience - F

Fun MF

Don't understand questions about girls M (answered there are differences)

Cool using computers - F

Appendix B

Student Interview Protocol

Introduction

Hi. As you know, I am conducting research in your classroom about students' participation, interest and learning when using Internet technology in science class. I have some open-ended questions for you today that will be an important part of the research. I will be taping the interview so I can have a record of what we talk about and I may jot down a few notes as well. Thanks for your time and interest!

Questions and prompts

- Tell me about your interest and learning in science class.
- Do you like science? Why or why not?
- Do you understand what you learn in science? Why or why not?
- Tell me about your interest in using computer technology.
- What do you like and/or dislike about the ways you use it?
- Do you think you are good at using computers? Why or why not?
- Tell me about your interest in using Internet technology, in particular.
- What do you like and/or dislike about the ways you use it?
- Do you think it is different from other types of computer activities? Why or why not?
- How does participating in this Internet science project influence your learning? (Does it help you learn or distract you? Explain.)
- How does participating in this science Internet project compare to using the Internet in other classes or for other science units?
- Is it more or less interesting? Why?
- Do you think there are any differences between boys and girls in terms of interest and learning in science? If so, why? How about in computer use? Is the Internet any different? If so, why?

Appendix C

Teacher Interview Protocol

Introduction

As you know, I am conducting research in your classroom about students' participation, interest and learning when using Internet technology in science class. I have some open-ended questions for you today that will be an important part of the research. I will be taping the interview so I can have a record of what we talk about and I may jot down a few notes as well. Thanks again for your time and interest!

Questions and prompts

- What have been your most successful experiences with using computer technology to support your science curriculum?
- What have been your least successful experiences?
- How much do you think the science content under investigation on the computer influences students' interest and participation? How much do you think the technology itself influences interest and participation?
- Do you think that the use of computer technology specifically impacts student learning? If so, how? In what ways? Why?
- Do you observe any differences between boys and girls in terms of participation, interest and learning in science? In the computer lab? If so, elaborate.
- What are some exceptions?
- Do you think there is any distinction between students' interest in Internet technology and other types of computer technology?
- Do students talk about or respond to them differently? If so, in what ways?
- Do certain types of students seem to enjoy one more than the other?
- Do you think that there is an Internet "culture" that differs from the larger computer culture?

Appendix D

Domain Analysis

Included Terms	Semantic Relationship	Cover Term
Email Talking with a partner Talking with a group Writing a paper Posting challenge question responses on Journey North Emailing questions to an expert	Is a way to	Communicate

Included Terms	Semantic Relationship	Cover Term
Working with a partner Working with a group Posting information on the website Using others' data for an assignment Sharing internet sites used to gather information via personal email	Is a kind of	Collaboration

Included Terms	Semantic Relationship	Cover Term
Personal socializing Telling jokes Not working on activity Laying head down Flirting Writing an inappropriate email message Turning off the microphone to talk Messing with computer hardware, pulling keyboard on and off, opening CD drive…	In an example of	Off-task behavior

Included Terms	Semantic Relationship	Cover Term
Working on activity Reading information Discussing project with others Drafting sincere email messages	Is an example of	On-task behavior

Included Terms	Semantic Relationship	Cover Term
Emailing peers Emailing a science expert searching websites for information Journey North including students' posted answers in the migration	Is a use of	The Internet

updates		

Included Terms	Semantic Relationship	Cover Term
Collecting local data Posting local data online Reading the migration updates, doing suggested activities Learning about migration patterns Predicting Following multiple migrations (sort of) Communicating with other students Collaborating with other students Participating for the full four months Communicating with an expert	Is an example of	The intended curriculum

Included Terms	Semantic Relationship	Cover Term
Using information for a research paper Following one migration Reading the migration updates, doing some suggested activities Students working individually Participating for 6 weeks Communicating with other students for fun Teacher sending three best questions to the expert Activities lack follow up in class, teacher does not facilitate answering critical thinking or big picture questions, helping them make sense of the project or the ways in which it is unique Project is mostly about completing worksheets for the migration updates and searching for information for their research paper	Is an example of	The enacted curriculum

Included Terms	Semantic Relationship	Cover Term
Navigating Getting lost Lack of experience Getting kicked off the internet Not sending messages, freezing or	Is a problem students have with	software

students losing their message Screen names taken when trying to set up email account Messages returned because email address typed incorrectly		

Included Terms	Semantic Relationship	Cover Term
Slow speed Bad Weather Too much network traffic Computer freezing	Is a problem students have with	hardware

Included Terms	Semantic Relationship	Cover Term
Observing Curriculum developer Information resource Source of help for students Pushing teacher to try new things Pointing out gender differences to the teacher Adding information for students when Laura is presenting an activity	Is a role of	The researcher

Included Terms	Semantic Relationship	Cover Term
Expert Novice Co-learner Activity coordinator, presenter Friend Discussion leader Setting the classroom atmosphere; either excited, stressed, frustrated, inexperienced, rushed… Answering student questions Decision maker Accepting students' ideas whether right or wrong (especially when pressed for time) Influencing students' attitudes toward and understanding of the Internet with her own interest and misconceptions	Is a role of	The teacher

Included Terms	Semantic Relationship	Cover Term
Computer teacher Lack of experience Lack of knowledge "out of comfort zone" Complex curriculum Too much work Stress Student behavior problems Too much time required to learn Classroom activities requiring a role change Frustration in computer lab	Is a	Barrier to success for the teacher

Included Terms	Semantic Relationship	Cover Term
Raising hand quietly Shouting out teacher's name Boys are more often perceived as science experts Boys are more often perceived as computer experts Boys view themselves as potential experts even when they aren't Girls say "I don't know" more than boys Girls defer to boys Comments like "he's a man, let him do it" More boys are regular participants in whole class discussions than girls, More girls than boys think that boys and girls are not equally talented in science and computer technology More girls than boys think that boys and girls don't participate equally in small group work More boys than girls agree that some students think girls are not supposed to like science In first visit, Laura spent much more time on boy side of computer lab, didn't see girls raising hands quietly for a long time Boys call out, get out of seats more than girls to get teacher's attention in the computer lab	Is a kind of	Gender difference

In lab, boys are more often louder than girls Boys tell sexual jokes or discuss sexual topics with each other or girls; girls are or act offended In classroom when allowed to select own seats, boys sit together at front tables, girls in back (see exceptions 5/22)		

Included Terms	Semantic Relationship	Cover Term
Katie Horner David Aborn, oriole expert Laura Crain, teachers Me, researcher Other topic experts in Journey North In skit, Daniel plays Aborn, Hannah is interviewer In skit, John presenting, Jenny holding poster quietly	Is a	Gender role model

Included Terms	Semantic Relationship	Cover Term
Researching the oriole Copying answers from JN Website on their checklist for research Writing a research paper Small group project: performing a skit, poster presentation… Having a group discussion of questions Writing email Looking for orioles Drawing tree buds Putting up an oriole feeder Posting local data Mapping data from Journey North Reading oriole updates Completing worksheets regarding oriole updates Posting answer to challenge questions Writing about their likes and dislikes of the project and computers	Is a type of	Student activity

Included Terms	Semantic Relationship	Cover Term
Not using a book Email Info is up to date It is faster than using a book for research Can access project on home computer as well as at school More information is available on the Internet than in a book Multi-media; songs, video, animation Games at home Internet is "useful"	Are things students like about	computers

Included Terms	Semantic Relationship	Cover Term
Too slow Problems: getting kicked off, not knowing how to navigate backwards, Some think computers are "bad" for kids, like dangerous people out there Frustrating when they lack experience Those who didn't know anything about computers were stressed and didn't enjoy it at first or at all CAI or tutoring programs (Sally)	Are things students don't like about	computers

Included Terms	Semantic Relationship	Cover Term
Doing hands-on projects Learning about their environment Learning about the way things work	Are things students like about	science

Included Terms	Semantic Relationship	Cover Term
	Are things students don't like about	science

Included Terms	Semantic Relationship	Cover Term
In small group, they lacked critical thinking skills Missed the big picture about migration and weather patterns Many details about the oriole; migration path, species, summer and	Are examples of	Student learning

wintering grounds, what it eats, what it looks like, nests, why they migrate, reproduction Increased proficiency with using computers and the Internet How to do email		

Included Terms	Semantic Relationship	Cover Term
Students sit in groups of four or five, sometimes assigned, sometimes self-selected 23 students total White, middle class Occasionally noisy, from their own class or next door Students are expected to be quiet while the teacher is talking The teacher leads question and answer sessions Occasionally students will question each other in front of the whole class Science class is often interrupted with special programs, testing, substitute teachers, field trips, etc. Students are given class time to work on assignments, research paper Sometimes students move to work with their friends after the teacher is finished presenting an activity Sometimes the divider is opened and two classes are taught at once Science is generally taught in a hands-on fashion, kids like it Using real-time data is not new, used in stock market unit in math and in building bridges unit in science Rarely use textbooks in science, teachers collaboration on science curriculum, proud to make it exciting	Is a description of	The classroom environment

Included Terms	Semantic Relationship	Cover Term
Some days are louder than others Students mostly work independently Some work with a same-sex partner Laura does not allow them to work in groups of three Students can choose a partner if they wish Students can select their own seats, except when I reorganized them for video-taping purposes The computer teacher is often there working quietly on one computer by himself – no interaction Sometimes kids from other classes and/or grades are in there working alone or with the computer teacher Toward end of project, students were getting bored with the same activities over and over again 19 computers in U-shape, IBM format Originally, boys sat on one side of room, girls on other with exception of one girl on boy side and 2 boys on girl side working together Laura circulates to help students' individually, occasionally breaks in to comment to whole class Not teacher-directed in here, students work on own Students often have to wait a long time to get help from the teacher Students are more off-task when they work with a partner	Is a description of	The computer lab environment

Included Terms	Semantic Relationship	Cover Term
Helping them with using the computer Probing their thinking to help them answer a question Telling them what she is excited about, e.g. putting up feeder, learning interesting information, brings in newspaper add about oriole feeders Stating she doesn't know the answer,	Is an example of	Teacher interaction with students

is learning along with them Disciplining the trouble-makers by stating expectations, sending them out of class to FOCUS, Calling students endearing names like honey, sweetheart, etc. Reprimanding students who are off-task Teacher tells girls how to do computer activity when they said they were doing fine after helping boys 5/7 Calls on Jenny in whole class discussion when she didn't raise her hand, thought she would have interesting input 5/14		

Included Terms	Semantic Relationship	Cover Term
Helping others on the computer Flirting Working together on the computer assignment Reading each others' email replies Arguing about an answer or procedures in small group work Passing notes Telling jokes or talking about sexual topics (boys to girls) Hitting each other in jest	Is an example of	Student interaction

Included Terms	Semantic Relationship	Cover Term
Stating hobbies Asking about their religion We've been studying the oriole Oriole and robin sightings Stating their age, Stating where they live Telling about their families Sharing what internet sites they use Telling about their school size Sharing that they are ready for summer	Is an example of	Email content

Included Terms	Semantic Relationship	Cover Term
Learning about the oriole Using the Internet Using the computer Using email, talking with kids in a different state Speed of email for communication Not using textbooks The animation on the website Current information Some liked working with a partner and being able to socialize in lab Able to go at own pace Hearing from an expert Learning about how real scientists work	Are things students like about	Journey North

Included Terms	Semantic Relationship	Cover Term
Some thought it was boring Took too long One didn't like the mapping activity Some said they didn't understand the project, (read big picture?) Wanted to interact more with students via email Some thought it was too much research, got boring Girl wanted to learn about some of the other animals the project followed Like hands-on science projects better	Are things students dislike about	Journey North

Included Terms	Semantic Relationship	Cover Term
Wanting to spell correctly on email message Asking me first thing if they are going to check their email Paying close attention to Laura's correspondence with another teacher Kids getting up to read other students' email replies Laura announcing their school's posting are on database Laura excited about girls' challenge question responses being on JN update John excited about his questions to	Is an example of	Motivation or excitement

the expert being answered Hannah excited about her responses posted on update Girl asks if they can keep using email account after project is over Tommy paying more attention because he was a focus student		

Included Terms	Semantic Relationship	Cover Term
Girl: "Yeah! Maybe we won't have to go to the computer lab!" (5/22) Boy who would rather do science out of a book - girl says "No you wouldn't" Girl, sarcastically: "This is such a cool way to learn!" - girl, "I think it is." Sally: "I'm not a computer person." Girl re: data sheet on computer 5/7: "I don't want to do this!"	Are comments that indicate	Students' dissatisfaction with computers or the project

APPENDIX E

Taxonomic Analysis

Main domains = environment, gender, computers, curriculum, student, teacher, researcher

- **Environment**
  - Science classroom
    - General information
      - 23 students total in class
      - 170 sixth graders, < 500 in whole school
      - White, middle class
      - Rural/suburban community
      - Located in unit outside of main, original building
    - Use of space
      - Students sit in groups of four or five, sometimes assigned, sometimes self-selected
      - Sometimes students move to work with their friends after the teacher is finished presenting an activity
      - Sometimes the divider is opened and two classes are taught at once
    - Use of time
      - Class is usually a 45 minute period
      - Science is generally 7th period of day, moved to 3rd period for most of Journey North
      - Teacher begins class with a presentation (review, information needed for the day's activities, instructions)
      - Sometimes students are to complete a reflection writing task for 5 minutes
      - Students are given class time to work on assignments, research paper
      - Science class is often interrupted with special programs, testing, substitute teachers, field trips, etc.
    - Atmosphere
      - Occasionally noisy, from their own class or next door
      - Students are expected to be quiet while the teacher is talking
      - The teacher leads question and answer sessions
      - Occasionally students will question each other in front of the whole class
      - Science is generally taught in a hands-on fashion, kids like it
      - Using real-time data is not new, used in stock market unit in math and in building bridges unit in science
      - Rarely use textbooks in science, three teachers on this team collaborate on science curriculum and are proud to make it exciting
  - Computer lab
    - General information
      - IBM format computers

        - Located in main school building
        - Full-time computer teacher's desk resides here
        - Teachers can sign up to use lab with their classes when available
    - Use of time
        - Usually have about 30 minutes to work in lab
        - Students come here after introduction in science classroom
    - Use of space
        - 19 computers in U-shape
        - Students mostly work independently
        - Some work with a same-sex partner
            - Tyler and Sally an exception toward end of project
        - Teacher does not allow them to work in groups of three
        - Originally, boys sat on one side of room, girls on other with exception of one girl on boy side and 2 boys on girl side working together
    - Atmosphere
        - Some days are louder than others
        - Students can choose a partner if they wish
        - Students are more off-task when they work with a partner
        - Students can select their own seats, except when I reorganized them for video-taping purposes
        - Laura circulates to help students' individually, occasionally breaks in to comment to whole class
        - Not teacher-directed in here, students work on own
        - Students often have to wait a long time to get help from the teacher because many students request help
        - The computer teacher is often there working quietly on one computer by himself – no interaction
        - Sometimes kids from other classes and/or grades are in there working alone or with the computer teacher
        - Toward end of project, students were getting bored with the same activities over and over again

- **Gender**
    - Differences
        - Observations of
            - Raising hand quietly – girls do this longer than boys in lab in general
            - Shouting out teacher's name – boys do this more often than girls
            - Boys are more often perceived as science experts by their peers and the teacher
            - Boys are more often perceived as computer experts by their peers
            - Boys view themselves as potential experts even when they aren't
            - Girls say "I don't know" more than boys
            - Girls defer to boys
            - Comments like "he's a man, let him do it"
            - More boys are regular participants in whole class discussions than girls

  - In first visit, Laura spent much more time on boy side of computer lab, didn't see girls raising hands quietly for a long time
  - Boys call out, get out of seats more than girls to get teacher's attention in the computer lab
  - In lab, boys are more often louder than girls
  - Boys tell sexual jokes or discuss sexual topics with each other or girls; girls are or act offended
  - In classroom when allowed to select own seats, boys sit together at front tables, girls in back (see exceptions 5/22)
- Teacher views of
  - In science class, knows three boys and one girl are primary contributers to class discussions
  - Says John will probably always have an answer, says rest of girls would have an opinion (not answer) if called on but don't volunteer
  - Girls that are especially strong students in language arts aren't as assertive in science
  - In computer lab, while a boy or two came in and "took over", no girls did that; they had less knowledge or less confidence with their knowledge than some boys
  - Before school group who comes to her room, boys use computer, girls don't
    - Girls complain boys are always on computer, but don't use it when it's free
    - Boy asked girl that morning to type his report for her, she did it
  - She thinks computers are viewed as a "man's deal"
  - Unclear as to whether experience with email was any different (see interview)
- Student views of
  - More girls than boys think that boys and girls are not equally talented in science and computer technology
  - More girls than boys think that boys and girls don't participate equally in small group work
  - More boys than girls agree that some students think girls are not supposed to like science
  - Students often waffle or contradict themselves when asked about gender differences
  - Many students discuss differences usually as individual, not gender specific
  - They acknowledge differences, have a hard time making sense of them

- Role models
  - Katie Horner
  - David Aborn, oriole expert
  - Laura Crain, teachers
  - Me, researcher
  - Other topic experts in Journey North
  - In skit, Daniel plays Aborn, Hannah is interviewer

        - In skit, John presenting, Jenny holding poster quietly

- **Computers**
    - Uses of
        - At school
            - Word processing
            - Internet
                - Email
                    - Peers
                    - Science expert
                - Research
        - At home
            - Word processing
            - Games
            - Internet
                - Email
                - Chat rooms
                - Games
    - Problems
        - With hardware
            - Slow speed
            - Bad weather
            - Too much network traffic
            - Computer freezing
        - With software
            - Navigating
            - Getting lost
            - Lack of experience
            - Getting kicked off the Internet
            - Not sending messages, freezing or students losing their message
            - Screen names taken when trying to set up email account
            - Messages returned because email address typed incorrectly

- **Curriculum**
    - Science
        - Science is generally taught in a hands-on fashion
        - Using real-time data is not new, used in stock market unit in math and in building bridges unit in science
        - Rarely use textbooks in science, teachers collaborate on science curriculum, proud to make it exciting
    - Journey North
        - Intended curriculum
            - Collecting local data
            - Posting local data online
            - Reading the migration updates, doing suggested activities
            - Learning about migration patterns

        - Predicting
        - Option to follow multiple migrations
        - Communicating with other students
        - Collaborating with other students
        - Participating for the full four months
        - Communicating with an expert
    - Enacted curriculum
        - Using information for a research paper
        - Following one migration
        - Reading the migration updates, doing some suggested activities
        - Students working individually
        - Participating for 6 weeks
        - Communicating with other students for fun
        - Teacher sending three best questions to the expert
        - JN including students' posted answers in the migration updates
        - Project is mostly about completing worksheets for the migration updates and searching for information for their research paper
        - Activities lack follow up in class, teacher does not facilitate answering critical thinking or big picture questions, helping them make sense of the project or the ways in which it is unique as much as I envisioned

- **Student**
    - Participation
        - Activities
            - Research activities
                - Reading oriole updates
                - Completing worksheets regarding oriole updates
                - Copying answers from the Journey North website on their checklist for research
                - Writing a research paper
            - Hands-on activities
                - Looking for orioles
                - Drawing tree buds
                - Putting up an oriole feeder
            - Communication activities
                - Writing email messages to peers
                    - Personal content
                        - Stating hobbies
                        - Stating their age
                        - Stating where they live
                        - Telling about their families
                        - Telling about their school size
                        - Sharing that they are ready for summer
                        - Asking about their religion
                    - Project/academic content
                        - Sharing what they've been studying

            - Sharing oriole and robin sightings
            - Sharing what Internet sites they use besides Journey North
        - Writing questions to an expert, teacher emailed three of them
        - Talking with a partner
        - Talking in a small group
        - Emailing answers to challenge questions to Journey North
            - Only 2 focus students had time to get to this (Sally and Hannah)
        - Writing a paper
        - Writing about their likes and dislikes of the project and computers
    - Collaboration activities
        - Working with a partner
        - Small group project: performing a skit, poster presentation…
        - Having a small group discussion of questions
        - Gathering and posting local data on the Journey North web site
        - Using others' posted data for a mapping activity
        - Sharing Internet sites used to gather research information in whole class or via personal email
- On-task behavior
    - Working on activity
    - Reading information
    - Discussing project with others
    - Drafting sincere email messages
- Off-task behavior
    - Personal socializing
    - Telling jokes
    - Not working on activity
    - Laying head down
    - Flirting
    - Writing an inappropriate email message
    - Turning off the microphone to talk
    - Messing with computer hardware, pulling keyboard on and off, opening CD drive…

- Interest
    - With computers
        - Likes
            - Not using a book
            - Using Email
            - Information is up to date
            - It is faster than using a book for research
            - Can access project on home computer as well as at school
            - More information is available on the Internet than in a book
            - Multi-media; songs, video, animation
            - Games at home
            - Internet is "useful"
        - Dislikes

        - Too slow
        - Problems: getting kicked off, not knowing how to navigate backwards,
        - Some think computers are "bad" for kids, like dangerous people out there
        - Are easily frustrated when they lack experience
        - Those who didn't know anything about computers were stressed and didn't enjoy it at first or at all
        - CAI or tutoring programs
            - Examples of
                - Girl: "Yeah! Maybe we won't have to go to the computer lab!" (5/22)
                - Boy who would rather do science out of a book; girl says, "No you wouldn't"
                - Sally: "I'm not a computer person."
- With science
    - Likes
        - Doing hands-on projects
        - Learning about their environment
        - Learning about the way things work
    - Dislikes
        - None stated
- With Journey North
    - Likes
        - Learning about the oriole
        - Using the Internet
        - Using the computer
        - Using email, talking with kids in a different state
        - Speed of email for communication
        - Not using textbooks
        - The animation on the website
        - Current information
        - Some liked working with a partner and being able to socialize in lab
        - Able to go at own pace
        - Hearing from an expert
        - Learning about how real scientists work
    - Dislikes
        - Some thought it was boring
        - Took too long
        - One didn't like the mapping activity
        - Some said they didn't understand the project, (read big picture?)
        - Wanted to interact more with students via email
        - Some thought it was too much research, got boring
        - Girl wanted to learn about some of the other animals the project followed

        - Like hands-on science projects better
        - Examples of
            - Girl, sarcastically: "This is such a cool way to learn!"
            - Girl re: data sheet on computer 5/7: "I don't want to do this!"
    - Examples of interest or motivation
        - Wanting to spell correctly on email message
        - Asking me first thing if they are going to check their email
        - Paying close attention to Laura's correspondence with another teacher
        - Getting up to read other students' email replies
        - John excited about his questions to the expert being answered
        - Hannah excited about her responses posted on update
        - Hannah asks if they can keep using email account after project is over
        - Tyler paying more attention because he was a focus student
- Prior Knowledge
    - Using the Internet and email was a new experience for many students
    - They had not apparently learned about the oriole in school before
    - Most had used computers before, mainly for word processing and games
- Learning
    - What they did learn
        - Many details about the oriole; migration path, species, summer and wintering grounds, what it eats, what it looks like, nests, why they migrate, reproduction
        - Increased proficiency with using computers and the Internet
        - How to use email
    - What they didn't learn
        - The big picture about migration and weather patterns
        - Critical thinking skills
- Interaction
    - With each other
        - Helping others on the computer
        - Flirting
        - Working together on the computer assignment
        - Reading each others' email replies
        - Arguing about an answer or procedures in small group work
        - Passing notes
        - Telling jokes or talking about sexual topics (boys to girls)
        - Hitting each other in jest
    - With the teacher
        - Asking for help
        - Sharing stories
        - Discussing content from migration updates
    - With the researcher
        - Asking for help
        - Sharing stories (one girl)
        - Asking about me, my work (several girls and boys)

- **Teacher**
  - Roles
    - Expert
    - Novice
    - Co-learner
    - Activity coordinator, presenter
    - Friend
    - Discussion leader
    - Setting the classroom atmosphere; either excited, stressed, frustrated, inexperienced, rushed…
    - Answering student questions
    - Decision maker
    - Accepting students' ideas whether right or wrong (especially when pressed for time)
    - Influencing students' attitudes toward and understanding of the Internet with her own interest/enthusiasm and misconceptions
  - Interaction
    - With students
      - Helping them with using the computer
      - Probing their thinking to help them answer a question
      - Telling them what she is excited about, e.g. putting up feeder, learning interesting information, brings in newspaper add about oriole feeders
      - Stating she doesn't know the answer, is learning along with them
      - Disciplining the trouble-makers by stating expectations, sending them out of class to FOCUS
      - Calling students endearing names like honey, sweetheart, etc.
      - Reprimanding students who are off-task
      - Teacher tells girls how to do computer activity when they said they were doing fine after helping boys 5/7
      - Calls on Jenny in whole class discussion when she didn't raise her hand, thought she would have interesting input 5/14
    - With researcher
      - Discussing curriculum plans
      - Sharing frustration with project and students
      - Discussing students' participation or lack thereof
      - Sharing excitement with project
      - Discussing personal life, family, school…
    - With other teachers
      - Collaborating on curriculum
      - Sharing curriculum
      - Discussing students' problems, frustrations with behavior
      - Sharing materials
      - Personal life, friendliness
  - Enthusiasm or interest
    - Announcing their school's posting are on database
    - Excited about girls' challenge question responses being on JN update

- Disinterest
    - Not pursuing feature of project that were new to her
    - Doing much of the project as a favor to me, not because she really wanted to
- Barriers to success
    - Computer teacher
    - Lack of experience
    - Lack of knowledge
    - "Out of comfort zone"
    - Complex curriculum
    - Too much work
    - Stress
    - Student behavior problems
    - Too much time required to learn
    - Classroom activities requiring a role change
    - Frustration in computer lab

- **Researcher**
    - Roles
        - Observer
        - Curriculum developer
        - Information resource
        - Source of help for students
        - Pushing teacher to try new things
        - Pointing out gender differences to the teacher
        - Adding information for students when teacher is presenting an activity
    - Interaction
        - With teacher
            - Writing curriculum, discussing how to do it
            - Asking for materials to complement lesson plans I created
            - Explaining goals of Journey north project
            - Explaining research goals
            - Discussing students' accomplishments in lab when she wasn't there
        - With students
            - Providing help in computer lab
            - Presenting/explaining a few activities (using email, research questionnaires, supplementing teachers' comments when presenting an activity I had created)
            - Interviews
            - Talking with them on route to computer lab about whatever
        - With other teachers
            - Meeting them
            - Discussing potential focus students
            - Pulling focus students out their class once for work in lab
            - Other teachers used some of the lesson plans I wrote as well

APPENDIX F

Componential Analysis

Dimensions of Contrast

Participation	Works independently	Works with a partner	Is off-task	Raises hand for help	Volunteers answers in science classroom
Hannah	Frequently	Rarely	Rarely	Sometimes	Sometimes
Sally	Frequently	Rarely	Sometimes	Frequently	Rarely
Jenny	Almost always	Rarely	Never	Frequently	Never
John	Almost always	Rarely	Sometimes	Rarely	Frequently
Tommy	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes

Dimensions of Contrast

Interest	In science	In computers	In the Internet	In Email
Hannah	High	High	High	High
Sally	High	Low	Medium	High
Jenny	High	High	Medium	Medium
John	High	High	Low	Low
Tommy	Medium	Medium	High	High

Dimensions of Contrast

Prior knowledge/experience	Using computers	Using the Internet	Using Email
Hannah	A lot	Some	None
Sally	Some	None	Little, watched dad
Jenny	Some	Little	None
John	Some	None	None
Tommy	Some	Some	Little

Dimensions of Contrast

Small group discussion	Volunteers answers	Ideas are accurate	Ideas are inaccurate	Is off-task	Says "I don't know"
Hannah	Sometimes	Frequently	Rarely	Rarely	Never
Sally	Rarely	Sometimes	Sometimes	Frequently	Frequently
Jenny	Frequently	Frequently	Rarely	Rarely	Once
John	Frequently	Frequently	Rarely	Rarely	Never
Tommy	Frequently	Sometimes	Sometimes	Frequently	Once

Dimensions of Contrast

Confidence/ assertiveness	In science content knowledge	In using computers	In small group discussion	In whole class discussions
Hannah	Strong	Strong	Strong	Medium
Sally	Weak	Weak	Weak, one exception	Weak
Jenny	Strong	Medium	Medium	Doesn't volunteer
John	Strong	Medium	Strong	Strong
Tommy	Somewhat strong	Strong	Strong	Medium

Dimensions of Contrast

Discussion of gender differences	**Hannah**	**Sally**	**Jenny**	**John**	**Tommy**	**Teacher**
In science class?	Girls work together more	Not discussed	No difference	Just different interests and points of view	Not really, shouldn't be any difference	Boys participate more, want to be noticed for their knowledge
Using computers?	Boys have more experience and knowledge	Boys have more experience, knowledge and interest	Behavior differences only, all could do well if they work at it, don't mess around	Different interests in what to do on computers	Boys are faster	Boys have more experience, confidence, and interest; "took over" in lab; anecdote of girl as secretary
Using Internet and email?	Girls write more sociable content than boys	Boys have more experience, knowledge and interest	Individual interest differences	Girls go shopping, boys get information and visit WWF	No difference	Girls do chat rooms, not boys; girls more into writing she thinks, some exceptions
Other comments				Genders have different views (Mars and Venus book), diffs will become more defined when older	Girls and boys should have "same opportunity"	Computers are "a man's deal"

Dimensions of Contrast

Curriculum	Collect local data	Post local data	Read migration updates	Learn about migration patterns	Make predictions	Follow multiple migrations
Intended curriculum	Yes	Yes	Yes	Yes	Yes	If possible
Enacted curriculum	Yes, some	Yes, some	Yes	No	No	No

Dimensions of Contrast

Curriculum	Write a research paper	Communicate with other students	Collaborate with other students	Communicate with an expert	Participate for four months
Intended curriculum	Yes	Yes	Yes	Yes	Yes
Enacted curriculum	Yes	Yes	Some	Yes	No

Dimensions of Contrast

Particular Interest	Hannah	Sally	Jenny	John	Tommy
In science	Experiments, likes a wide variety of topics, working in a group	Hands-on projects, building bridges	Simple machines, hands-on activities	Chemistry, electronics, how things work, animals, matter	Animals
In computers	Card games, neopets, love calculator, email, chess in yahoo game room	Chatting on email	Internet, games, likes working by herself	Games, research information, sports statistics	Internet, race car games, flying, solitaire, email

Dimensions of Contrast

Email	Hannah	Sally	Tommy	John	Jenny
Set up own account	Yes	Yes	Yes	No	No

APPENDIX G

Activities I created for Laura and her students to use

Challenge Question Response

Directions:

1. Log onto Netscape Communicator.
2. Click on the mail button with an envelope picture beside it.
3. Click Log On.
4. Enter the screen name: ____________
5. Enter the password: middleschool
6. Click "sign in".
7. Select the "write mail" button.
8. To: jn-challenge-oriole@learner.org
9. CC: leave blank (that means carbon copy to another address)
10. BCC: leave blank (that means blind carbon copy to someone else so no one will see that the message was sent to that them)
11. Subject: Challenge Question #8
12. Type your message: give your answer to the challenge question.
13. Click "send".
14. You should get a message that says, "Your mail has been sent."
15. You're done!

Name ____________________

Journey North Classroom Exchange

Many students around the country are participating in Journey North this spring. We will email messages to other students in ________ to meet them online and exchange information.

Brainstorm some things you would like to share with them about yourself.

Socially | About the project

Brainstorm some things you would like to find out from these students.

Socially | About the project

<u>Directions</u>

1. Log onto Netscape Communicator.
2. Click on the mail button with an envelope picture beside it.
3. Click Log On. (If you want to, you can create your own email account before proceeding with the rest of the directions. To do so, click on sign up, then make up your own screen name and password. Follow the directions to get your new account. Then follow the rest of the directions starting from number 7.)
4. Enter the screen name: ___________
5. Enter the password: middleschool
6. Click "sign in".
7. Select the "write mail" button.
8. To: ___________
9. CC: leave blank (that means carbon copy to another address)
10. BCC: leave blank (that means blind carbon copy to someone else so no one will see that the message was sent to that them)
11. Subject: enter something like "hi!" or "hello from ___________"
12. Type your message: in this box write your message to the kids in their class. Review it and revise it if need be before you click send.
13. Click "send".
14. You should get a message that says, "Your mail has been sent."
15. You're done!

TEACHER VERSION

Journey North Classroom Exchange

Many students around the country are participating in Journey North this spring. We will email messages to other students in _________ to meet them online and exchange information.

Show overheads of messages exchange then describe activity.
Before we go to the lab, review the advantages of setting up an email account.

Brainstorm some things you would like to share with them about yourself.

Socially	About the project
Tell about self/school/location Hobbies, whatever	What they have studied, learned

Brainstorm some things you would like to find out from these students.

Socially	About the project
Ask about them personally (what do They like to do, etc)	What have they studied? Oriole Trees leafed out? When? Any other data they would like to get from a distant site?

Directions

1. Log onto Netscape Communicator.
2. Click on the mail button with an envelope picture beside it.
3. Click Log On. (If you want to, you can create your own email account before proceeding with the rest of the directions. To do so, click on sign up, then make up your own screen name and password. Follow the directions to get your new account. Then follow the rest of the directions starting from number 7.)
4. Enter the screen name: __________
5. Enter the password: middleschool
6. Click "sign in".
7. Select the "write mail" button.
8. To: _____________
9. CC: leave blank (that means carbon copy to another address)
10. BCC: leave blank (that means blind carbon copy to someone else so no one will see that the message was sent to that them)
11. Subject: enter something like "hi!" or "hello from ___________"
12. Type your message: in this box write your message to the kids in their class. Review it and revise it if need be before you click send.
13. Click "send".
14. You should get a message that says, "Your mail has been sent."
15. You're done!

Email Exchange Reply Directions

Definitions of email menu bar options

Get Mail – read new or old mail in the inbox

Write Mail- draft a new message

Address Book- where you can store email addresses

Reply- write a message back to the person who wrote the one you're reading

Reply All- write a message back to all the email addresses a message came from and was sent to

Forward- send the message you're reading to someone else

Delete- erase a message – don't delete ANYTHING during this project!!

When you find a message that someone wrote back to you from the class in ____, click **reply** to write back to them. This way you won't have to type in the email address again, and your previous correspondence will appear at the bottom of the message.

Name ____________________

Post Your Local Sighting

A big feature of Journey North is that people in the United States, Canada and Mexico help track spring's journey north. People participating in the project follow some or even all of the migrations and signs of spring and then report when they occur in their hometown. Scientists and students use these data to study where, when and how animals migrate and to understand how migrations and signs of spring vary from year to year. Scientists really couldn't get such a vast amount of data without all the participants across the hemisphere!

What data can you report to add to this collaboration?

Directions:

Log onto the Journey North website. (www.learner.org/jnorth)
Click on the Owl button "Report Your Sightings"

1. Enter a registered email address: ______________

2. Use the arrows to scroll to select what you want to post (leaf-out any species, oriole feeder up, first oriole sighted, oriole nest).

3. Press here for email validation. Wait for it to process.

4. Fill out the field data form completely. Here's what you will be asked to enter. Some of these will already be filled in for you.

- Date of sighting MM/DD/YY – be sure to enter the date you FIRST noticed leaf-out or the date you FIRST spotted the oriole, not today's date!
- Nearest town
- Select a state
- Country (USA) should already be in there
- Latitude and longitude of sighting (optional, they can add it)
- Comments about sighting
- Observer's name
- Teacher's name
- Grade
- School name
- City
- State
- Email address
- SUBMIT YOUR SIGHTING RESET (erases everything)

-Over-

Discussion questions

1. Why is the latitude and longitude information important?

2. What kinds of people do you think participate in Journey North who aren't students?

3. What kinds of problems could come from so many people posting their local sightings?

4. How might scientists handle these problems?

TEACHER VERSION

Journey North Spring 2001 Database
Using the Data

Students, scientists and other Journey North participants have been posting their local sightings on the website this spring like you just did the other day. We can use this data like scientists do to monitor the migration pattern of the oriole and dates when trees leafed-out. In this activity you will access the database of all these sightings and plot them on a map of the United States and Canada. You will want to use colored pencils to distinguish between the sighting dates.

Here's what to do

- Decide what you want to plot (first oriole sighting or leaf-out, any species).
- Decide how you will design your map. There will be lots of data dating back to February. You may decide to color code date ranges like blue for February 1-15, red for February 16-28, etc. Or you could write the dates on the map (though this may get cluttered and be harder to interpret than a color-coded map.) Don't forget to make a key on your map indicating what each color represents.
- If you choose to plot the oriole migration, beware that data from the Bullock and Baltimore Oriole are both on there. Select either the eastern or western half of the country to plot, or else you will be mixing the two species.
- When you get into the computer lab, follow the directions below to find the database.
- When you are finished, we will ask for several volunteers to present their maps to the class so that others can learn about the data they didn't use.
- Answer the discussion questions on the back of this paper with a partner.

Directions in the lab

1. Log onto Journey North (www.learner.org/jnorth)
2. Click on the Owl button for Report your Sightings
3. Go to the section called Spring 2001 database
4. Use the arrows to scroll to select the event you want to plot on your map (leaf-out or oriole sightings).
5. Show Data Reported in the last 120 days- use the arrows to select 120
6. Press Here
7. The data will come up in a table format that you can use to plot on your maps. Using the latitude and longitude data will be the fastest way to plot each sighting.
8. There are too many dates for you to plot all of them, especially if you are doing the oriole. Choose 10-15 sightings from each month to plot on your map.

Discussion questions

SEE CURRICULUM ACTIVITY PAGE 55-56 FOR IDEAS REGARDING THESE QUESTIONS.

1. What patterns do you notice in your data?

2. Were there any "outliers" or strange data that didn't make sense to you? If so, what are some possible explanations for these?

3. How would you go about finding out whether to believe the strange data or not?

4. Here are some reports that were submitted during a previous Journey North season. Read them and decide whether you would believe their accuracy or not. Why would you accept or deny each report?

- A kindergartner in Minnesota reported a sighting of 500 monarch butterflies in Minnesota in February. The kindergarten teacher said her students were just learning to identify monarchs at the time.

- On April 9, a monarch was reported in New Jersey. Other monarchs reported at the time were in Georgia, Alabama, Kansas and Missouri. The New Jersey report was sent by a naturalist who tags hundreds of monarchs each fall.

- A student in College Station, Texas, reported seeing his first monarch on May 20. Many monarchs were reported in Texas in March and April.