KINDERGARTEN GIRLS “ILLUMINATING” THEIR IDENTITIES-IN-PRACTICE THROUGH SCIENCE INSTRUCTION FRAMED IN EXPLANATION BUILDING: FROM THE SHADOWS INTO THE LIGHT

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ABSTRACT

Recent research on young children’s learning has revealed that they are capable of sophisticated scientific reasoning and has prompted a new era of reform framed around the integration of three main strands – core disciplinary ideas, scientific and engineering practices, and cross-cutting themes. Given the documented issues with girls in science in later grades, I chose to examine their participation in scientific norms and practices in kindergarten to gain insights into their identities-in-practice. From the perspective of identity as an enactment of self, I used the lens identities-in-practice (Lave & Wenger, 1991) to examine the impact that having classroom science instruction framed around constructing explanations with evidence would have on the girls in the class. In this study, I drew from theories of sociocultural learning, positioning, and identities-in-practice to study: a) the norms of participation, b) the authoring and positioning of girls, and c) the identities-in-practice that the girls’ enacted in the kindergarten science classroom.

Using a research design informed by qualitative methods and participant observation, I analyzed data using a constant comparative approach and crafted case studies of four girls in the science classroom. Three assertions were generated from this study: a) Identity-in-practice manifests differently in different literacy practices and shows how students chose to be science students across time and activities- a focus on one literacy practice alone is insufficient to understand identity; b) The ways in which the teacher positions girls, especially “quiet” girls, is essential for engaging them in productive participation in science discourse and learning; and c) A focus on classroom science instruction grounded in constructing explanations from evidence provided a consistent framework for students’ writing and talking, which facilitated the establishment of expectations and norms of participation for all students. Implications from this study for elementary school science teachers, professional developers, and university researchers, and a direction for future research are provided after the analysis.
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Carpe Diem
Chapter 1

INTRODUCTION

In this chapter, the reader will find the driving force behind my study, a brief overview of the general issues surrounding the problem space, and the importance of newly crafted reform documents and their impact on my study as I share my research questions and defend my focus on girls in science before describing the intent of the chapters throughout my dissertation.

Defining the research problem

Where are the girls in science?

My story. “Paul, why does knowing the species of salamander that you are looking at help you with talking about the ecology of the region?”

“I don't know,” said Paul.

“Dan, what do you think?”

Silence. At this point I started to wonder why my professor wasn’t calling on me. Instead of asking me to answer the question, he went on to explain why he felt it was imperative to know the species in a region that you are studying. My answer would have sufficed. I wanted to say that certain species are indicators of the health of a region, but I was not chosen. This was not a lone occurrence. I frequently had my hand up in the class to answer a question or to ask a question and did not have the floor opened to me.

This Herpetology class was comprised of a total of five members, Pedro, the male professor, three male classmates, and myself. We went on hikes in the forest, mapped out areas to
study, counted species, took tests, and wrote lab reports. Unlike my classmates, I was never asked to help with carrying the lab equipment, but my other classmates were frequently asked to help. I was never asked to help with the trapping of a snake, but I watched as my classmates took turns using the stick. When Pedro wasn’t leading the discussion or demonstration, I took my own turn handling the snakes and using the equipment in the field, but I started to feel angry and overlooked by my professor.

At the end of the semester, we were given a participation grade, along with our test grades, and lab grades. My test grades were okay, my lab grades were good, but my participation grade was average, and my classmates all received better participation grades than me. I asked Pedro how he came up with the participation grades and he said that he just did. There wasn’t a rubric he followed, or any other justification for our grade. There was just a slip of paper with an average grade on it for me. I was not happy with his answer (on this occasion and others prior to this), so I made an appointment to see our Dean. I felt that the way I had been treated in the class and the subsequent grade I received was not fair. I explained how the semester unfolded to the Dean, to which he told me he was not surprised. He said Pedro had a hard time teaching women due to his cultural background and that I wasn't the first person who had an unpleasant experience in his class. There was nothing he could do for me, but he promised to speak with Pedro. The Dean’s response was what motivated me to begin my doctoral studies and think critically about girls’ access to science teaching and learning.

As I tried to understand the conundrum surrounding why I didn't get the same grade as my male counterparts and why I wasn’t asked to participate, as frequently, I knew that there were multiple factors that affected my learning in this particular science class. It is indisputable that historical, cultural, societal, and political factors, to name a few, influence a teacher’s teaching and student learning within an institution. As I tried to understand more about my situation, I began to research and think more critically about the positioning of girls in science.
Historic positioning of girls in science

Historically women and girls have been marginalized within the space of science (e.g., Brickhouse, 2000; Longino, 1993; Sadker & Sadker, 1995). Sadker and Sadker suggest that girls are traditionally positioned with less power in the science classroom (1995). Girls are called on less frequently than boys and not given as much time or encouragement when they answer questions in the classroom. Teachers often ask girls lower level cognitive questions, while boys are challenged more frequently, as reported in the book, Still Failing at Fairness by David Sadker and Karen Zittleman (2009). Girls are historically left out of the explicit curriculum, the curriculum that is written down and followed more diligently. They are rarely included in pictures within the text or used as examples within the textbook (Sadker & Zittleman, 2009). Some researchers suggest that girls also learn that their scientific identity may be antagonistic to their gendered identity, which may be enforced by how they are positioned in the curriculum and classroom (Sadker & Sadker, 1995).

A report from the National Research Council indicated that girls were falling out of the “pipeline” (2006) and not obtaining jobs in STEM-related fields, although girls on average get higher grades than boys in science courses (Marcon, 2002). Similarly, the National Academies also reported that women are being lost along every educational transition that they are in contact with as their interest declines (2007). A lack of women in science creates an imbalance of perspectives and design ideas for society and is detrimental to our global society.

After experiencing negative positioning in my college class, I began to wonder about the positioning that may be occurring at different grade levels within science education classes, particularly at the early elementary level. I frequently heard from many of the college students that I taught (who were placed in elementary classrooms) that they did not see science in their classroom settings.
What are the persistent issues associated with teaching elementary science?

So we need to ask ourselves, why are student teachers reporting that they do not see science in their elementary classrooms?

Pre-service and in-service teachers are quick to point out that they feel less comfortable with science content; thus, it becomes an easier block of time to either dismiss or fill with something minimally related to the discipline (coloring apples or making a hand turkey). As reform movements place importance on authentic science learning and practices, elementary teachers generally lack both coursework and experience that contribute to the development of coherent scientific concepts and knowledge (Davis & Smithey, 2009). Not only do teachers need to understand the science content and practices associated with phenomena, which they are teaching, but they also need to understand how to teach it. Research demonstrates the importance of teachers’ own conceptual content understanding for teaching (Ball, Thames, & Phelps, 2008), as well as the domain specific Pedagogical Content Knowledge (PCK). That is knowledge of science teaching strategies, of curricula, of children’s common ideas and misconceptions, and of assessment (Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013) for helping children understand important scientific concepts and practices. Knowing that these strategies exist and being introduced to discipline specific content on a few courses may not be enough for many educators to feel comfortable with teaching such a complex discipline.

When elementary teachers are asked about their role in the science classroom, many say they see themselves as “dispensers of facts” (Tilgner, 1990). They often feel that they should always have the right answer and avoid situations where they might not be able to supply the correct information to their students. Or, they may rely heavily on a text book or curriculum materials for teaching science so that they have an authoritative guide for helping with student questions and curiosities. In both cases, teacher beliefs about their role in the classroom and about
science in general influence their teaching of science in their classroom (Levitt, 2001). However, elementary teachers often exhibit a lack of confidence about scientific content knowledge and a lack of pedagogical content knowledge for teaching science (Davis & Smithey, 2009; Schwarz, 2009; Weiss, 1994; Zembal-Saul, 2009). Moreover, they usually do not see themselves as affiliated with science, e.g., “I’m not really a science person.” This lack of confidence or anxiety associated with teaching science coupled with varying degrees of specific knowledge of content and practices and pedagogical content knowledge may be enough to deter teachers from taking up science instruction in their classrooms; however, this is not where the dilemma ends. Many teachers are experiencing intense pressure from their school districts and state departments of education to focus their instructional time with students on literacy and numeracy concepts due to assessment regimes.

Due to the introduction of NCLB, the Common Core and state assessments, teachers have been asked to focus a majority of their instructional time on literacy, numeracy, and test-taking strategies (ethnographic notes, 2011). Even with this new pressure and focus on literacy and numeracy policy makers, administrators, educators and researchers cannot deny the that science instruction is necessary in the early elementary school. The aforementioned problem areas have existed within the context of teaching elementary science for quite some time. These areas have been researched and used as focal areas when planning professional development for teachers and instruction for education students. However, with the changing atmosphere in education, science education has undergone a series of revisions marked by the research that has been conducted about young children’s thinking and learning within the science context.

New standards, new curriculum, new pedagogies, new ways of teaching

Early education classrooms are full of vibrancy and multimodal opportunities to learn.
Children come into these classrooms each year with experiences and rich stories to tell. Elementary school is the perfect time to teach science, as the students come into the classroom with natural curiosities about the world around them (Duschl, Schweingruber, & Shouse, 2007). Not only are young children curious about their surroundings, they come to the classroom with “rich knowledge of the natural world” and the capability to explore their understandings, regardless of their socioeconomic position. Young students may be more likely to thrive in areas where their personal, prior experience with the natural world can be connected to scientific ideas (Duschl, et al., 2007, p. 119). Along with the increased attention to science education since the launch of Sputnik (Driver, 1989; American Association for the Advancement of Science [AAAS], 1993; National Research Council (NRC), 1996), researchers have been developing new frameworks and goals for science education.

The research synthesis document, *Taking Science to School*, edited by Duschl, Schweingruber and Shouse (2007), was a catalyst in re-envisioning K-8 science education. This book contained research from the science education and educational psychology communities and re-conceptualized proficiencies in science to include four interconnected strands in children’s development. The four strands include a) knowing, using, and interpreting scientific explanations of the natural world, b) generating and evaluating scientific evidence and explanations, c) understanding the nature and development of scientific knowledge, and d) participating productively in scientific practices and discourses (Duschl, et al., 2007). These strands helped to shape the new framework, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, (NRC, 2012), and in turn, the new science standards, Next Generation Science Standards (NGSS) (NGSS lead states, 2013).
Focus on science education within the new reform documents

The newest reform documents focus on the integration of core disciplinary ideas, scientific and engineering practices, and cross-cutting concepts (NRC, 2012). The NGSS are beginning to inform state standards, curricula, teacher education and professional development, and assessment. One area within the new framework and standards reflects an emerging emphasis on science practices, such as explanation construction and argument. Explanation construction and argument are two different practices that scientists engage in with their work. Building explanations requires that the learner have an understanding of the phenomenon under study and provide evidence for their explanation, along with the scientific reasoning that completes their explanation (Zembal-Saul, McNeill, & Hershberger, 2013). Some researchers understand argumentation and explanation construction as similar entities, whereas others offer distinctions among them (McNeill, Lizotte, Krajcik, & Marx, 2006). In this study argumentation and explanation construction are treated as different practices. An argument differs from constructing an explanation in that learners are vying for their own explanation as the answer to a scientific question. While they argue, the learners are distinguishing between different explanations, determining which explanation includes related evidence, analyzing the explanations for opinions and facts, among other factors. Constructing explanations differs in that it is a practice that involves using observations and/or data in combination with science ideas to explain scientific phenomenon. With an increased emphasis on scientific practices, implementing these new reform documents into the early elementary classroom will most likely impact the teaching of school science.

Within these reform documents, members are calling for equitable science education. The framework states, “Science education should be able to provide all students with the background to systematically investigate issues related to their personal and community
priorities” (NRC, 2012, p. 11-1). This call does not state that every young child should grow up
dreaming of becoming a pharmacist, nurse or chemical engineer, or even that every child should
be taking advanced science and engineering courses. What it does say is that every child should
be able to participate in the “spheres of life” and, as the world is gaining in complexity, so is the
need for a greater knowledge of science and engineering (NRC, 2012).

Research on how new science curricula and teaching practices can engage and support
girls, English Language Learners, urban students, and lower SES groups is growing (Barton &
Lee, 2006; Carlone, 2004; Lee, 1999; Longino, 1993). Others have investigated the influence of
new curricula on discourses, identities, and practices that shape how students view both the
scientific world (Latour & Woolgar, 1986; Longino, 1993) and the social worlds of science
(Barton, Tan, & Rivet, 2008; Metz, 2004; Moje, Collazo, Carillo, & Marx, 2001).

In light of these studies, the implementation of reform-based documents within
elementary schools, and my personal experience, I am interested in girls’ access to science
education within the changing context of early elementary science. Moreover, I chose to be in the
kindergarten classroom because it is within this space that girls may come into contact with
science as a school subject for the first time. Additionally, with the challenging disciplinary
knowledge, historic positioning of girls in science, and the changing landscape of science
education, I feel that I can add to the body of literature about how young girls experience science.

Unpacking the constructs of the study

This research focus requires consideration of the following; science as a community of
learners, positioning, and identity. In order to research and understand the community that I
described, I need to unpack the constructs that frame young girls’ access to science in the early
grades. As I look at these three theoretical constructs, I envision the following model, Figure 1.
The science classroom consists of a community of learners, each with their own thoughts, comfort levels, and ways of doing science, including the teachers. Lave and Wenger (1991) called this community, a community-of-practice, where the learners are learning from the environment and their interactions with others. The kindergarten classroom is socially constructed by the ways the inhabitants are doing science associated with the disciplinary-based practices of science (Kelly & Chen, 1999; Reveles, Cordova, & Kelly, 2004). These practices are connected to not only content, but also to context (Reveles, et al., 2004; Tobin, Elmesky, & Seiler, 2005).

When thinking about the context of the kindergarten classroom, situated within the practices of science (NRC, 2012), I view identity work as an essential element of how the practices of science are taken up or not taken up within the community. I align myself with the construct of identity as a fluid entity that is constructed socially within community, and therefore known as the identities-in-practice (Lave & Wenger, 1991). Therefore, this entity is affected by the positioning of oneself or how one is positioned within the community. Specifically, how

Figure 1-1: Theoretical model of the kindergarten science classroom
students’ discursive identities are formed based upon the scientific literacy practices that students are surrounded with in the classroom (Brown, Reveles, & Kelly, 2005). Therefore, my representation of the theoretical constructs in the kindergarten classroom depicts the community surrounding the positioning because the community-of-practice may have a direct affect on the positioning of members within the scientific community. In turn, the positioning within the scientific community may have an impact on the scientific identities-in-practice of the inhabitants. This is not a new model, in fact Barton, Tan, and Rivet (2008) used a similar model when looking at hybrid spaces for identity development among girls in science, but it is a new model with respect to looking at kindergarten girls’ access to science instruction with a focus on constructing explanations with evidence.

**Research questions**

Using the framework delineated above and defining the problem space of girls’ access to science teaching and learning, this study aimed to investigate a context in which the social practices of science were highlighted within the evidence-based explanation-building practice, which supports the NGSS and new science education framework (NGSS lead states, 2013; NRC, 2012). The context was a kindergarten classroom that was chosen because of the teacher’s self-reported attempts to implement reform-oriented practices in her classroom, specifically science instruction that was focused on constructing explanations with evidence.

Within this specific context, the study aimed to view girls’ access to science instruction and learning, their participation in scientific discourse and practices, and their identity work as they were exposed to reform-oriented science. Out of these parameters of study, the following research questions were asked:
1. How are the norms of participation co-constructed within Caroline’s kindergarten classroom?

2. How are kindergarten girls authoring themselves (as science learners) within this classroom?

3. How are the kindergarten girls positioned (as science learners) within this classroom?

4. What are the girls’ developing identities-in-practice in this classroom?

Defending a focus on young girls

For kindergarteners, learning science becomes a “process of coming to be, of forging identities in activity” (Lave & Wenger, 1991). As students participate in the group, sharing evidence from an investigation or their ideas about a claim they are thinking about making, these students are taking a brave step into the practices of science. They are trying out new words, patterns of speech, and ways of making sense within their classroom science community. They may be asserting new ideas or disagreeing with a classmate and it is within this space that girls may be faced with challenges.

Specifically accounting for the authoring and positioning of girls within the kindergarten science classroom I am afforded insight into how and when the girls take up scientific practices within the science learning community. I am able to observe whether they are marginalized within this context and how that may or may not affect their participation and identity work in practice (Barton, Kang, Tan, O’Neill, Bautista-Guerra, & Brecklin, 2013).

Audience and purpose

This research study aims to inform educators, policy makers, researchers, and parents about girls’ access to science teaching and learning and subsequent identity work in practice in a
reform oriented kindergarten science classroom. Without research about the implementation of the practices of science within the science curriculum at the earliest years of formal schooling, we are losing the opportunity to encourage and support both future citizens who enjoy and know how to use scientific concepts and practices in their lives, as well as women who see themselves as scientifically affiliated and could pursue science and engineering careers.

Positive learning experiences in the early elementary classroom, within a scientific learning community, could provide the opportunity for younger students to shape their identity and become more competent in scientific endeavors (Carlone, 2004). What happens in kindergarten may have an effect on how children view science in later grades and how they take up opportunities available to them as they develop their scientific identities. Across the grades, one might expect that students’ interests and participation in valued discourses and practices would contribute to increasingly sophisticated scientific learning, resulting in more scientifically informed citizens (Barton, et al., 2008).

This study aims to add to the body of research on science teaching and learning by showing the ways in which kindergarteners participate in science, by showing how norms are established within this classroom context, by analyzing how girls are positioned or not positioned as science learners, and by adding to the body of research on identity work, which may lead to new findings associated with the authoring of oneself in nuanced ways in and across settings.

**Preview of remaining chapters**

As you read my dissertation you will be taken through the sequence of the study and the decisions I made while conducting the study. In chapter two, I introduce my theoretical framework and how I define learning in science. Within this chapter I also include a review of the pertinent literature surrounding my research focus; girls in science, elementary science, young
children’s scientific thinking, and science identity as it is shaped by positioning and the social practices of science.

Chapter three denotes the decisions I made in conjunction with my research methods, informed by my research methodology and theoretical constructs. In chapter three the context of the study is defined, data collections methods are described, along with the steps involved in the analysis of my research questions.

Chapter four lays out the analysis of the co-constructed norms in the beginning of the year within the kindergarten classroom. The science norms are compared to norms within other disciplines in the classroom, as well as, the teacher’s participation in norms surrounding whole group instruction and individual activities. This chapter sets the stage for more in-depth analysis of the case studies within the community-of-practice.

In chapter five the case studies of four girls are described, bound by the thematic unit of curriculum, Light and Shadows. Each case study looks at the authoring of the girls and the positioning of the girls within this unit as it adds to the shaping of the girls’ scientific identities-in-practice.

A cross case comparison can be found in chapter six along with the assertions that I make about how the context of, and participants in, the reform oriented classroom afforded the space to develop scientific identities-in-practice.

The final chapter includes comments about the implications of this research study, revisits the limitations of the study, and implies where future research in this area could benefit the science education community, along with the education community at large.
Chapter 2

REVIEW OF LITERATURE

In this chapter I will unpack my theoretical beliefs in sociocultural learning, identity, positioning, and authoring, and provide a review of literature and research studies that have shared some commonalities and differences with my study.

Learning theory: Sociocultural theory and situated learning

Sociocultural theory and situated learning

This study is grounded in the theoretical view that science is a set of sociocultural practices (Vygotsky, 1978), and that learning is situative in nature (Cobb, 1994; Greeno, 1997; Greeno, Collins, & Resnick, 1996; Lave & Wenger, 1991; Wenger, 1998). Science knowledge is produced by participants involved in its practices. What counts as “science” changes over time and space, and is enacted by the community in which it resides. The community impacts science as the science practices impact the community. In other words, the learning of science is situated within a context in time where learners participate in the community. As Greeno and colleagues (1996) synthesized the situated learning perspective:

“Success in cognitive functions such as reasoning, remembering, and perceiving is understood as an achievement of a system, with contributions of the individuals who participate, along with tools and artifacts. This means that thinking is situated in a particular context of intentions, social partners, and tools.” (p.20)
Participants in the community of practice achieve success through their participation within the community, and, as Lave and Wenger (1991) state, “mastery of knowledge and skill is recognized when novices move toward full participation in the sociocultural practices of the community” (p.29). New members, e.g., kindergarten students, are introduced to the school science community as a novice. Novices are afforded and assigned different social positions due to the interactional contexts and norms of a relevant local community. Novices may decide to participate in the community, ignore the community, or even challenge the community, and in doing so, tailor their identity within the community, or communities of practice (Lave & Wenger 1991; Wenger, 1998). As learners continue to participate in the community of school science, they move along a continuum of participation, and their exposure to disciplinary practices becomes increased.

Due to the definition of socially constructed knowledge, one setting cannot be transposable to another similar setting because the learners in each setting are faced with different cultural constructs and social practices, which guide and influence their learning. However, context is not constrained by the physical location of the setting, as social contexts are fluid and are constituted by the interactions of the people around them (Geertz, 2000). As girls participate within this community, by engaging in discourse, participating in investigations and activities, and using tools, they are forming and reforming identities in relationship to their teachers and peers.

**Identity as socially situated**

Using a sociocultural framework that describes learning as changing, iterative, and situated in context and environment around the learner (Brown, Reveles, & Kelly, 2005; Lave & Wenger, 1991; NRC, 2011) makes it imperative to look at discursive identity, as identity is
situated in the performative self, which is dynamic, iterative, and responsive to its surrounding environment (Bucholtz, 1999; Butler, 2004). This is essential to achieving understanding of the girls’ access (positioning and authoring) to science in a classroom. I view identity as fluid, changing upon context and exposure, and socially situated. Similarly, my view of identity was informed by my understanding of the book, *Identity and Agency in Cultural Worlds*, written by Holland, Lachiotte, Skinner, and Kain (2001). Their view of identity is that it is co-constructed by the person and by other people with whom they interact in the context of social activity. Holland et al. (2001) stated, “Identities become important outcomes of participation in communities of practice” (p.57). Focusing on identity brings the issues of participation and non-participation to the forefront when observing communities of practice (Wenger, 1998). As Wenger stated, “Identity includes one’s ability or inability to shape the meanings that define our communities and our forms of belonging” (1998, p.145); building an identity occurs as the meanings of membership are negotiated in the social community. In this study, I am not looking at only individuals as I analyze identity, but I am looking at identity between the individuals and the social context, each informing the other.

Therefore, researching identity is a valuable contribution to understanding the outcome of participation in a socially distributed science class, and thus informed my study. In addition, studying identity may lead to new findings associated with the authoring of oneself in nuanced ways in and across settings. This could transform the cultural meanings of science learner within the local context and then as resources for future groups (Wortham, 2006) because students create and re-create identities in relationship to the scientific community, providing messages about who they are and who they want to be within this community (Gee, 2000; Tan & Barton, 2007a; Tan & Barton, 2007b).
Positioning and authoring within a community

Identities are not just found in practice, but are subject to the position of the individual and the community of practice. In developing a practice, community members must engage with and acknowledge each other as participants. The way that members of the community author themselves as members and negotiate the way they have been positioned by the community has an impact on the formation of the community. When positioning is mentioned in this research study it refers back to the definition of positioning as described by Davies and Harré (1990). This research pair stated, “Positioning is the discursive process whereby selves are located in conversations as observably and subjectively coherent participants in jointly produced story lines” (p. 48). They describe the differences between interactive and reflexive positioning as where what one person says positions the other, and where the person positions oneself, respectively. Positioning, as stated above, does not always occur unintentionally (Davies & Harré, 1990). Positions are identified when a participant conceives of themselves within a community and observes how they are taken up in that space. Also noted, positioning does not always occur intentionally.

As most children interact in the world, they begin to feel comfortable or uncomfortable with others, with objects, and with subject matter. Children position themselves as certain types of people as they take up certain spaces within the community and are thereby positioned by the community in a certain way. When children co-construct their positioning within their participation of social practices, they construct views about themselves and about others (Gresalfi, Martin, Hand, & Greeno, 2008) and “these views may change based upon how they position themselves, how they are positioned by others, or by the resources afforded and legitimized within a given context” (Varelas, Kane, & Wylie, 2011, p. 828). By using positioning as a theoretical construct I am able to view the girls’ access and learning in the community as it
“affects the process of their identity development” (Tan & Barton, 2007a, p.4). In the same respect, paying attention to the authoring that occurs within the community also contributes to the process of identity development. Participants in a community author their identities in a variety of ways and at a variety of times, or chose not to author their identities at all. These participation patterns, or “spaces of authoring” (Holland, et al., 2001) help to provide an understanding into the developing identities within the school science community, as participants take up the discourse or chose not to take up the discourse of the community. Authoring and positioning are intertwined in that participants may chose to author an identity as a science learner, for example, because they have been positioned as a science learner by another member of the school science community. Oppositely, participants may author their identity as a science learner even when they have not been positioned as such, emphasizing the need to look at positioning and authoring collectively when studying school science identity.

**Identities-in-practice**

Looking at the positioning of young girls’ knowledge building and the authoring of identity within the social context of science may lead to insights on their identity development. Therefore, I am using the aforementioned theoretical constructs to define identities-in-practice (Barton, et al., 2008; Lave & Wenger, 1991). Identities are developed within the science classroom as learners test their position in the class by engaging or not engaging with the science practices and norms of the class, and authoring or not authoring identity in this space. “Identities-in-practice” in the context of this research refer to the identities girls obtain or choose to take on while they are immersed in scientific discourse. As Brown and colleagues (2005) argue, “the use of scientific discourse, because of its presuppositions regarding sociocultural practices, challenges science educators to understand the complex affiliation between language, identity, and science
learning (p.790). Practices, language, artifacts, and worldviews all reflect social relationships among members in a community (Wenger, 1998). Science has a discourse associated with it, and this discourse is reiterated throughout the research literature, standards, and practitioner journals. Practices of science are part of this scientific discourse and are critical to the function of a scientific community.

Differentiating between “identities” and “identities-in-practice” is an important consideration in this study because, as already stated, the discourse within the community and the participants in the community affect the novices within the community, and how they take on their identities-in-practice (Barton, et al., 2008). Practice in identities-in-practice refers to the practice of scientific discourse. How the members of this school science community participate is socially situated within this community. How novices negotiate their authoring space and roles in this community with other members and more positioned experts determines how their identities-in-practice evolve. Members of the school science community in this study are seeing how they fit in with the discourse of this community, how the discourse shapes them and their thoughts. They are deciding whether to participate or not, and whether to author an identity or not, along with seeing if their ideas hold importance, and if their questions get taken up. They may or may not author identities as science learners in this space, and may stay on the periphery as novices. As Holland, et al., stated, “The space of authoring, of self-fashioning, remains a social and cultural space, no matter how intimately held it may become. And, it remains, more often than not, a contested space, a space of struggle” (2001, p. 282). Again, these constructs remind the reader of how identity is fluid and changing based upon one’s interactions in a social world. Identity-in-practice becomes evident through discourse and interaction, and the success or failure of becoming a member in this school science community may be subject to how students are
allowed to position themselves with the members of the community, the subject of science, the discourse practices, among other factors (Reveles, Kelly, & Durán, 2007).

People, including young children, look at the world from the positions into which they are persistently cast. That is not to say their positions are fixed. They are not, and as their involvement with the social practices of science change, so may their positioning, their authoring of identities, and their evolving identities-in-practice.

By defining the theoretical frames and constructs that my study reflects, I have positioned my study in a specific space, the science education community. By doing so, there are affordances and limitations placed upon my work. By framing my study with the lenses of social practices of science, positioning, authoring, and identities-in-practice, I aimed to provide new literature that would help to inform the science education community with new data concerning the authentic engagement of girls’ participation in science instruction that was focused on scientific discourse, specifically the practice of constructing explanations with evidence. This practice is taken up in the new framework (NRC, 2012) and throughout the Next Generation Science Standards (NGSS Lead States, 2013), where they include kindergarten performance expectations as demonstrating proficiency in asking questions, planning and carrying out investigations, analyzing and interpreting data, and engaging in argument from evidence, to name a few. In selecting these constructs and frames for my study, I realize that I am limiting the embodiment of student identities to the identities-in-practice for this specific school science community, therefore limiting the analysis to the affordances of specific science practices and there impact on students’ identity work.
To further understand the decisions, methodological and theory-based, that I made within the study, it helps to also include literature that helped to inform my thinking and decision-making when it came to planning and carrying out my study.

**Girls’ identity work**

**Marginalization and positioning**

In order to understand girls’ access to science in a kindergarten classroom and the constraints and/or affordances of being in a classroom where the social practices of science are elevated, I first needed to look at the historic positioning of girls in science. Girls have been marginalized in science, positioned as less able, and even though this may be changing, it still shapes the historic and cultural norms surrounding science (Sadker & Sadker, 1995).

Olitsky, Flohr, Gardner, and Billups (2010) conducted research in an eighth grade classroom with ethnically, racially, and socioeconomically diverse students. They found that not only did the school perpetuate the positioning and marginalization of the students by making selections for them, but the teachers, administrators, and peers forwarded the discourse by passing along negative stereotypes, which posed obstacles for students wishing to develop their scientific identity (Olitsky et al., 2010). As stated before, positioning may not be an intentional act, as corroborated by Boldt. In discussing the unintentional positioning that makes it way to how a teacher sees a student, Boldt pointed out in her paper:

“Walkerdine asked teachers to evaluate students as mathematicians. She found that the way the teacher evaluated the students was prominently based on gender as the teacher looked for rationality in the boys answers and did not expect to see
that in the girls answers, therefore positioning the girls as irrational mathematicians” (2002, p. 8).

This research finding by Boldt reemphasizes the historic positioning of girls, albeit in another context, and the effects that positioning may have on the developing identities-in-practice of young students. This informed my study as I was reminded that not only is the positioning of a member of the school science community going to be visible or audible at times, it may exist in artifacts within the context as well.

Archer, Dewitt, Osborne, Dillon, Willis, and Wong (2010) conducted a longitudinal, five-year study, beginning with ten and eleven-year-old children, asking them questions about their interests in science, among other things. They found through qualitative analysis that science was already, at an early age, “being constructed in gender terms; whereby, girls were being connected to “school science” environments and boys were being connected to “grown-up” science environments” (p.622). Elementary school was seen as “safe” science and secondary school was seen as “dangerous” science. Boys in this study actually mentioned that they didn’t think girls should be involved in dangerous science, positioning the girls into a less powerful space, thereby possibly affecting the identities-in-practice of the girls. Not only did reading this study help me by encouraging me to study what girls think about science and how they position themselves within the science classroom, but it also showed me a longitudinal view of positioning and its effect on students’ beliefs about science.

As I began visualizing what my study might look like before it was truly designed, I thought that having science instruction in a classroom in early elementary school would be beneficial and that students would learn about science practices as they encountered the different science disciplines. After I read the research study by Varelas, Pappas, Kane, Arsenault, Hankes, and Cowan (2011) about young African American children’s thinking and talking science, I was aware that the rest of the daily norms that are set in the elementary school might also be
foregrounded in my study. Varelas, et al. (2011) found that children’s ideas and positioning were related to what “doing school” involved. Looking at the children’s science journals and asking them questions about the journals helped to elicit a feeling that, “doing school” is “doing science.” The children reported that following rules for behavior and being smart were what made them successful at school. The same children had constructed rules for science as well. These rules included capital for themselves as scientists and for other scientists in the field (2011).

Another group of studies that helped to fashion the way I approached my study and how I decided what was integral concerning positioning and marginalization among girls in science were studies by Carlone, Haun-Frank, and Webb (2011) and Tan and Barton (2007a; 2007b). Carlone, et al., (2011) compared two fourth-grade classrooms where teachers who were committed to reform-based science were teaching science. The research team noticed that some African-American and Latina girls did not feel like they were “science people” and in the process of determining why the girls felt this way, Carlone and colleagues discovered there was a difference in the way the classrooms were “sharing scientific ideas” (2011). This study made me wonder what reform-based science afforded the students in the class and what constraints it provided in the defining of a scientific person and science practices. I also valued what Carlone and colleagues reported in their findings when they said that reform-based science measures do not necessarily create an equitable science education. Tan and Barton’s study (2007a) added on to my developing ideas about the effect of the positioning of girls in the science classroom. They stated in their study, “How students are positioned in the science classroom affects the process of their identity development” (2007a, p. 4). The research pair reported that students were being positioned as “novices,” “loud,” “dramatic girl,” “field-trip girl,” and “generous girl” based on their identities from outside of the science classroom, as well as “group leader”, and “reporter” due to their positioning within the classroom (Tan & Barton, 2007a). Not only did the positioning in the science classroom affect their identities-in-practice, but also their positioning from outside of the
classroom affected them as well. These studies helped me to think about how to frame my study and what to look for and where to look for it.

**Girls’ identities in science**

Separating positioning and identities-in-practice is an artificial divide, and for that matter, the research articles and literature included in this section more predominantly focus on the identities-in-practice of girls in science. Research concerning science curriculum and girls in the past ten years has centered on reform-based efforts in science. Researchers have been studying the effects of reform-based science (RBS) on girls’ attitudes, achievements, and engagement in science or STEM. Heidi Carlone’s study of high school girls taking part in a RBS physics curriculum, *Active Physics*, highlighted the importance of understanding the school culture, as well as the curriculum in the school, in the interest of the uptake of scientific identities. Regardless of the curriculum, the girls in her study demonstrated resistance in the promoted meanings of both science and scientist (2004). The girls were more interested in a good student identity than any uptake of a science identity, which made me question if this would happen in early elementary school as well.

Another study that corroborated Carlone’s findings for me was a study by Brickhouse and Potter (2001) that demonstrated the complex relationship between school and science identity among urban girls. The girls in this study struggled with taking on a science identity because of their positioning with their out of school identity. In both of these studies the girls were cautious about taking on a science identity because of the other identities they possessed at different times. The high school girls in Brickhouse and Potter’s study demonstrated that their two identities were juxtaposed and neither felt comfortable for the girls to take up.
Barton and colleagues (2008) studied the same identity take-up as Brickhouse and Potter (2001), but in a middle school setting. Barton and colleagues looked at the hybrid space, the space between school and home that uses takes-up elements from both spaces, and how the identities-in-practice develop across these spaces. The urban middle school girls in their study provided evidence toward the strategies used to bridge the participant’s social worlds and the world of science education in the classroom. The researchers found that merging of practices was generative and developed over time, lending evidence to policy and practice constituents (Barton et al., 2008). Again, this study helped me with my developing ideas about what affects girls’ developing science identities and the scope of data sources that may be useful to study. This study, however, was also conducted on middle school girls and I wondered if I would be able to have as much access to young elementary students in the same manner. Usually middle school is a time ripe with after-school opportunities situated within the school, and early elementary students do not seem to have as many of these opportunities afforded to them. Barton and colleagues reported that “successful participation in school science, despite a lack of resources in the home environment, can be better facilitated when students have a science-related identity they can draw upon” (Barton, et al., 2008 p.75-76).

**Girls’ interest in science careers**

I researched articles that delineated scientific identities in relationship to success in STEM fields or careers because I felt it was important to have an idea of the trajectory of this work. As STEM careers continue to be a focus in national government, and colleges and universities are devising programs for the recruitment and retention of STEM majors (Corbett, Hill, & St. Rose, 2012), educators need to be aware of their impact on the nations’ workforce. The STEM workforce is suffering because of the marginalization of women and girls within this
space (Brickhouse & Potter, 2001; Sadker & Zittleman, 2009). Not only is there a need for talent within the STEM workforce, but they are in need of more women in these fields. Girls’ interest in science dramatically declines, compared with boys’ interests, as students transition into middle school. Women continue to be underrepresented in a number of science and engineering fields and on the science and engineering faculties of many colleges and universities (NRC, 2011, p.11-3). In a study by Carlone and Johnson (2007), they spoke with successful women in undergraduate science and science careers and found that women who had a disruption in their science identity had a more difficult time staying on the science path than women who had a more solid science identity along the way. This study made an impression on me, as it looked at a final stage science identity and had the participants look back at their past science learning. This made me feel that beginning in an early elementary classroom would help to inform the field, especially with early scientific identity development in practice. With that being said, I then needed to look at the research studies and literature surrounding elementary school science.

**Elementary science teaching**

On a daily basis, elementary teachers face a wide range of challenges, including both curriculum decisions and instructional practices. These teachers are faced with multiple subjects to teach and limited amounts of time for instruction. Within the subject of science, additional challenges are unearthed due to the multiple domains that teachers are required to cover such as life science, physical science, and earth science. As reform movements place importance on authentic science learning and practices, elementary teachers generally lack both coursework and experience that contribute to the development of coherent scientific concepts and knowledge (Davis & Smithey, 2009).
Activity-mania in elementary school science

Elementary teachers have been found to lack sophisticated understandings about the nature of science (Abd-el-Khalick, 2001) and tend to emphasize the use of hands-on activities as a way to interest, motivate and engage young students (Abell, Bryan, & Anderson, 1998). The TIMMS Video Study, an international comparison of science teaching at the eighth-grade level, provides evidence to support the use of hands-on learning in elementary classrooms. This study reported that 44 percent of U.S. science lessons had weak or no connections among ideas and activities and 27 percent did not address science concepts at all (Roth, et al., 2006). Elementary teachers of science may rely heavily on a textbook or scripted curriculum material for teaching science so that they have an authoritative guide for helping with student questions and curiosities.

In essence, in the interest of inquiry and a more student-centered focus, many elementary teachers feel the need to fill the time and space of science with activities, a process, which Moscovici and Nelson term “activitymania” (1998). This is done in order to keep the natural curiosity of the students alive, rather than focus on learning science.

Pedagogical content knowledge for teaching elementary school science

Specialized knowledge and practices for giving priority to student-centered learning requires the application of specific pedagogical content knowledge (PCK). Shulman’s seminal work on PCK, Those Who Understand: Knowledge Growth in Teaching, describes the meaning behind PCK as “the ways of representing and formulating the subject that make it comprehensible to others” (1986, p. 9). Much research has been conducted about elementary teachers’ PCK for science teaching and science education reform, and a few studies suggest the need for more in-depth studies into this area of teaching and practice due the next generation reform that shifts
focus away from stand alone content and places it on core disciplinary knowledge, practices of
science and cross-cutting themes (Bryan & Abell, 1999; Darling-Hammond, Hammerness,
Grossman, Rust, & Shulman, 2005; Smithey, 2008).

One study that supports findings in this area was conducted by Avraamidou and Zembal-
Saul (2005) and highlights the use of PCK in a classroom where the teacher is enacting reform-
based science instruction. This study highlights the importance of having guidance and support
when developing teachers are testing new frameworks and trying to teach with reform-based
practices. In this classroom, the teacher gave importance to student beliefs and had students
collecting and analyzing their own evidence in order to explain the science concepts that were
being questioned. Another study conducted by Bryan and Abell (1999) described the tensions felt
by a teacher when thinking about her vision for science teaching and her enacted practices. This
teacher confronted her tensions by reflecting on her practice and trying new practices that aligned
more with her beliefs.

Examining teachers’ PCK also implies that one should be examining teachers’ content
knowledge—the knowledge about the disciplinary content, biology, earth science, chemistry, to
name a few. Many teachers say that they have a lack of content knowledge (Allen, 2006), and
they do not know how to teach science, so they leave it out of their school day. Science contains a
wealth of specialized knowledge, and can be intimidating and problematic for elementary
teachers to teach (Appleton, 2005; Davis, Petish, & Smithey, 2006). As Van Driel, Beijaard, and
Verloop (2001) stated, beginning teachers experience a conflict between their personal beliefs
about science teaching and science and their own practice, emphasizing the difficulties that lie
with not struggles with content and teaching the content.

The studies mentioned concerning elementary teachers’ knowledge about content and
pedagogy influenced my decision-making process throughout my study. They were helpful in
allowing me in to a world of what an elementary science teacher might be thinking about before, during, and after their lessons.

**Science anxiety**

An interesting facet that may influence the comfort of teaching science in the classroom for elementary teachers are the images that teachers accumulate throughout their schooling which “tell” them what teaching and learning should look like. These images may help to produce or magnify the teacher’s beliefs and practices within their classroom (Levitt, 2001). Qualitative studies that have followed beginning teachers into their classrooms and reported on their beliefs found rather sophisticated and emerging patterns (Avraamidou & Zembal-Saul, 2005; Garbett, 2003). These studies report teachers believe that teaching and learning science should be student centered, where students would be active participants, that science should be personally meaningful to them, that positive attitudes toward science should be fostered and that the role of the teacher should change to accommodate the students’ learning. Teaching science in this way calls for a specific type of knowledge in handling the content and practices within the classroom, and this may increase teachers’ anxiety toward teaching science. Lederman, Gess-Newsome, and Zeidler (1993) concluded in their study that teachers reported that their beliefs and experiences were not dealt with in trying to reconcile their science teaching practices and their beliefs about science instruction.

Teachers, school districts, and science educational researchers also face a dilemma when the implementation of new reform philosophies and practices face incompatibility with teachers, curricula, or districts current programs and design, creating a gap between the intended principles of reform and the implemented principles of reform (Levitt, 2001). On all accounts, teachers need to feel comfortable with the reform movements so as to be able to teach within the new measures.
In all cases, teacher beliefs about their role in the classroom and about science in general influence their teaching of science in their classroom (Levitt, 2001). When elementary teachers are asked about their role in the science classroom, many say they see themselves as “dispensers of facts” (Tilgner, 1990). They often feel that they should always have the right answer and avoid situations where they might not be able to supply the correct information to their students.

Teacher anxiety about the subject matter and teaching the subject matter creates a problematic space that may directly and/or indirectly affect student learning. In a survey administered by Horizon, Inc. titled, *2012 National Survey of Science and Mathematics Education: Status of Elementary School Science Teaching* (Banilower, Smith, Weiss, Malzahn, Campbell, & Weis, 2013), participants answered multiple questions concerning their feelings about science teaching and their preparation for teaching science. Less than one-third of the teachers surveyed said they felt qualified to teach each of the science disciplines (Banilower, et al., 2013), and more of them reported that they felt more qualified to teach life sciences or earth science than physical science. In contrast, 77% of teachers surveyed felt very well qualified to teach language arts. A research study conducted by Marx and Harris corroborates the findings of this survey as they reported that teachers often say they feel more prepared to teach language arts than any of the science disciplines (2006).

**Focus on literacy, numeracy, and assessment**

Not only does teacher anxiety about science teaching and science content affect the science classroom, but an increased focus on other disciplines also affects time for science learning. The student day is frequently filled with reading, writing, and math instruction, with the occasional science and social studies (Marx & Harris, 2006). Many elementary teachers have science scheduled as the last subject in their day and forego teaching it in their classrooms.
because they have run out of time. As Weiss reports, the modest amount of time spent teaching science may imply the unimportance of that subject compared to others (1994).

With recent national reform measures, particularly the No Child Left Behind (NCLB) Act of 2001, a greater emphasis on reading and mathematics has dominated elementary classrooms, particularly early elementary grades, where children are developing their nascent reading, writing, and mathematical skills. The pressure of the NCLB accountability, in which students are assessed on language arts and mathematics, has directed attention away from science; and placed more time and resources on language arts and mathematics (Marx & Harris, 2006). With less time in the day to work on other disciplines, many teachers and students spend a minimal amount of time focusing on science. It has been reported that instructional time spent on teaching science in grades 1-4 varied from 6-13% (National Institute of Child Health and Human Development, 2005). It was not until later in elementary school that more instructional time was committed to science (Jones, Jones, & Hargrove, 2003). Lee and Luykx (2005) reported that some elementary principals have told their teachers to only focus on language arts and mathematics for the two to three months preceding the accountability tests. An additional study by Diamond and Spillane (2004) concluded that the performance of the school did not predicate the emphasis on taking time before the test dates to solely focus on language arts and mathematics. They reported results from four urban elementary schools, two were high performing and two were low performing, that indicated that all schools in their study were affected by accountability and testing policies (Diamond & Spillane, 2004).
An impetus for reform: Young children’s thinking in science

**Recent history of reform in science education**

Provoked by the launch of Sputnik, science education reform movements have fluctuated for decades. Efforts have been directed at many foci from specific content knowledge wherein students are expected to learn all discipline-related content so that they may one day become a scientist, to efforts directed at supporting all students so that they gain similar science knowledge (standardized curriculum) in order for students to become competitive and productive in a society. As international comparative testing became a mode of assessing our scientific potential and knowledge as a nation, the reform movement focused on science for all because we needed to “fix” our society’s lack of science knowledge by creating a national standards movement.

With No Child Left Behind mandates approaching in 2006, the world of science education, again, swung with the pendulum. Students were now to be assessed and schools ranked, funded, and compared based on science assessment scores. Science educators began thinking about the improvement of science education in a different light. Science standards were brought to the forefront as assessments were aligned to the standards.

Many scholars and research reports describe scientific inquiry as a *knowledge building process*, where explanations are used to help make sense of the data (AAAS, 1993; Duschl, 2000; NRC, 2000, 1996; Sampson & Clark, 2008; Sandoval & Reiser, 2004). Students are expected to use evidence to identify patterns, construct claims, and construct explanations or alternative explanations. In turn, these explanations are crucial for understanding the phenomena in question, and for designing new questions surrounding the phenomena, as emphasized in the *National Science Education Standards (NSES)*. In the *NSES*, the authors describe what is central to inquiry by stating, “students describe objects and events, ask questions, construct explanations, test those
explanations against current scientific knowledge, and communicate their ideas to others” (1996, p. 2). In the companion text, *Inquiry and the National Science Education Standards (INSES)*, the authors expound upon the standard of inquiry by detailing key features within the content standard. These features include an emphasis on evidence and explanation building, wherein the “learner engages in scientifically oriented questions,” “learner gives priority to evidence in responding to questions,” “learner formulates explanations from evidence,” “learner connects explanations to scientific knowledge,” and “learner communicates and justifies explanations” (NRC, 2000, p.29). Whereas the reform movements in the past focused on what science content to teach at which level, new work seemed less concerned about “fixing” what and when to teach, but now looked at answering questions about how science is learned, how it should be taught, and what research was needed to understand how students learn science (Duschl, et al., 2007, p 1).

Influenced by the field of the learning sciences with findings focused on K-8 students, this seminal piece, *Taking Science to School (TSS)*, began to focus on young children’s thinking and learning.

**Young children’s thinking and learning in science**

One of the reasons for this lack of documentation prior to this seminal piece was due to the Piagetian perspective that young children are concrete thinkers and flow systematically through developmental stages, creating developmental constraints on young children’s involvement in practicing science (Metz, 2004). Emphasis was placed on deficits and stages of abilities, which generalized children’s capacities and reflected the conception of cognition on which early constructivism was based (Duschl et al., 2007; Robbins, 2005).

Numerous researchers (e.g., Gelman & Coley, 1991; Inagaki & Hatano, 2006, 2002; Metz, 2004; Michaels, et al., 2008; Robbins, 2005; Smith, Carey, & Wiser, 1985; Tytler &
Peterson, 2000; Varelas, et al., 2008; Zembal-Saul, et al., 2013) have thought differently of Piaget’s early developmental distinctions and have argued for a more robust introduction to science learning and literacy for young children in school science. These studies suggest a focus on early elementary science as a fruitful endeavor when trying to understand the affordances and constraints of reform-based science teaching.

Young children have been defined as being innately curious about how the world works. They question many things around them on a daily basis and try to investigate their surroundings for answers to these questions. They make observations and record their observations so that they’ll be ready for later discussion and they change their questions after hearing classmates’ findings (Smith, Remy, & Cowan, 2009).

Not only are young children curious about their surroundings, they come to the classroom with “rich knowledge of the natural world” and the capability to explore their understandings, regardless of their socioeconomic position. Young students may be more likely to thrive in areas where their personal, prior experience with the natural world can be connected to scientific ideas (Duschl et al., 2007, p. 119). Specifically addressing how children learn, Duschl et al., state:

Children entering school already have substantial knowledge of the natural world, much of which is implicit. What children are capable of at a particular age is the result of a complex interplay among maturation, experience, and instruction. What is developmentally appropriate is not a simple function of self or grade, but rather is largely contingent on their prior opportunities to learn. Students’ knowledge and experience play a critical role in their science learning, influencing all four strands of science understanding (2007, p.2).

When comparing perspectives of both Piagetian and non-Piagetian literatures, Metz (1995) found that children appear capable of much richer scientific thought than was once described. They are able to construct theories, go beyond just observation and classification processes, think
abstractly beyond hands-on activities, and design and complete investigations requiring control and inference. Others have also iterated what Metz found in various literatures. Gelman & Coley (1991) concluded that when a researcher goes beyond the surface in asking children about their thoughts concerning natural things and really probes to uncover their thinking, children in their preschool years use categories that are theory-laden and that stem from trying to understand the environment, not merely organize it.

Researchers, Smith, Carey, and Wiser (1985), also had the same conclusion as Gelman & Coley when working with young children (preschoolers) and their theories about size, weight, and density. These researchers observed that the preschoolers thought about weight as a physical variable, which would affect other objects. Young children do have different capacities of theorizing, which may be attributed to their limited domain knowledge and less access to theories surrounding that knowledge; however, research literature supports “a much richer framework for young children's science instruction, wherein the processes previously approached in the elementary school grades as ends in themselves become tools in a more contextualized and authentic scientific inquiry” (Duschl et al., 2007, p.121). Considering the aforementioned studies, as well as my continued interest in and focus on reform-based science, I am motivated to continue my quest for more information as to how these measures could impact the girls’ access to science in an early elementary classroom.

**Next Generation Reform**

Just a few years ago, a new framework was published for the science education community. This framework, *A Framework for K-12 Education: Practices, Crosscutting Concepts, and Core Ideas*, represents efforts made by educators and scientists to re-conceptualize K-12 science education in a way that includes practices, crosscutting concepts, and core ideas
(National Research Council [NRC], 2012). This new framework concedes that the way our science standards are written, to date, creates the problem of “a mile wide and an inch deep” curriculum that is as difficult to teach, as it is to learn in a student’s formative years. The new framework addresses this concern by supporting limited core ideas with a focus on the concepts that cut across these ideas and the practices that are enforced throughout the process of science.

As the field of science education moves to a better understanding of what science learning entails for the teacher and the learner, and how to best teach the concepts and processes needed to enhance our children’s scientific literacy, questions unfold about when to introduce specific content or to have students participate in complex practices. Within the new framework, attention has been given to learning progressions of core ideas and much of the framework is written in grade level bands. Explanation is given to each grade level band for what is anticipated that students will learn within a core idea based on their grade in school. Due to the cognitive research science educators have reported about young children’s learning in science, great attention has been paid to including early elementary learners within the bands of the new framework (NRC, 2012). Having a new framework to inform science teaching further provides me with a context to use in the kindergarten classroom. Knowing that a stated focus of the new framework was directed toward young children made me keenly aware of the potential of this framework as a tool for future research.

**Explanation building as a practice of science**

Now that I knew the focus of the science teaching context would be centered on the new framework, I began to look for research focused on its parts, within classrooms, to inform my study. Duschl, et al., stated, “Concern with explanation and investigation are a key component to children’s scientific literacy proficiency and learning at all ages and “even the youngest children
are sensitive to highly abstract patterns and causal relations” (2007, p. 54). Adding to the sentiment of what Duschl, et al., reported, Driver and colleagues explained that they see the “youngest students as most likely to use phenomenon-based reasoning (which makes no distinction between observation and explanations)” (1996, p. 141). However, Tytler and Peterson (2000) observed young children’s responses to evaporation in which five-year-old children were making meaning from their observations, fluctuating in their answers, and demonstrating conceptual change through their responses to the researchers. Each of the studies suggests that looking at young children’s reasoning and explanation building would be fruitful to understand their knowledge development. Even Kuhn and Pearsal (2000) report about a study in which six-year-old children were sensitive to evidence as a source of knowledge to support the truth of a claim, whereas four-year-olds were fragile to this distinction. This is another instance in which the science education community continues to build its claim that young children are capable of using evidence to construct explanations in school science and evolving in their practice of explanation building.

Building a productive science learning community is an important step of proficiency in science. Not only does it represent the communication that is enacted within science communities of practice, but it also generates participation from all members of the science classroom. The Claims, Evidence, and Reasoning (CER) framework, described in the book, What’s Your Evidence?: Engaging K-5 Students in Constructing Explanations in Science (Zembal-Saul, et al., 2013) foregrounds science practices in the new framework and provides a framework for a classroom focused on science instruction explanation building with evidence. “While asking students to provide evidence-based explanations, students are engaged in authentic scientific practices and discourse, which can contribute to the development of their problem-solving, reasoning, and communication skills,” writes Zembal-Saul and colleagues (2013, p. 7-8). The CER framework was originally implemented with students in grade 5-8 by McNeill and Krajcik
(2011), and as researchers began to think more about young children’s scientific reasoning, was later used in the publication mentioned above with students in grades K-5.

Within the CER framework, students and teachers are exploring and investigating science phenomenon with a question in mind. In order to answer the question, teachers engage students in finding evidence that would support their claim, or answer to the question. After students and teachers co-construct their claim, they provide the evidence that they used to answer their question, and provide the reasoning for how the evidence supports their claim (McNeill & Krajcik, 2011; Zembal-Saul, et al., 2013).

In classrooms where students are asked to present their claims and evidence in order to build explanations, emphasis should also be given to adopting norms of practice while they write, read, and talk about their claims as they learn the language of science (Michaels, Shouse, & Schweingruber, 2008). Based upon my analysis of these articles, authenticity is a salient argument for using an evidence-based explanation-building framework in the science classroom. I claim that this argument is authentic because the practice of constructing explanations from evidence represents processes that are used in settings in which “science” takes place. Not only am I interested in girls’ access to science in reform-based classrooms, but it needs to be authentic to them, as well, which may, in turn, lead to a more connected scientific identity across contexts.

By understanding the different principles associated with being proficient in scientific literacy, members of the scientific community have a common framework in which to help students develop meaningful scientific knowledge. Underscoring this idea Duschl et al., wrote:

When students develop a coherent understanding of the organizing principles of science, they are more likely to be able to apply their knowledge appropriately and will learn new, related material more effectively. Knowledge of the salient, factual details is necessary but not sufficient for developing an understanding of the discipline and its core ideas and principles (2007, p. 120).
The abilities associated with this framework are consistent with twenty-first century skills necessary for future endeavors and decision making in a democratic society (Krajcik & Sutherland, 2009; Zembal-Saul, et al., 2013).

Evidence is central to scientific practice. Being able to collect evidence, negotiate what is sufficient evidence, and use evidence to construct a claim is essential to scientific proficiency. Designing fair tests, making predictions, collecting, recording, and representing data are all practices that students need to learn to perform when they are learning about meaningful science concepts (Duschl et al., 2007; Michaels, et al., 2008; Zembal-Saul, 2009). Students’ increasing understanding of the importance of evidence-based explanations also supports their growth in the field of science.

My study is informed by ideas surrounding these pieces of literature and the previous studies mentioned in this review, but it differs in that I focused on girls in the kindergarten classroom as they were introduced to science instruction as an evidence-based explanation building practice. Knowing that I view science knowledge as socially constructed, and that this not only includes science content knowledge, but the practices of science as well, helped me to frame the activities that occur within the knowledge-building and sense-making space of the kindergarten classroom. Not only do the social practices of science help to inform my observations of student learning, but looking at the positioning of girls in this specific group and the authoring of their identities-in-practice also help to inform the ongoing wondering of young girls’ access to science. Barton, et al. (2013) suggest, “It is through the actions people take and the relationships they form that they position themselves as particular kinds of people over time and space” (p. 5). To that end my study was foregrounded by my “standing on the shoulders of giants” that went before me. They made it possible for me to visualize a study that will add to the base of research about young girls’ identities-in-practice in a classroom with science instruction focused on constructing explanations from evidence.
Chapter 3

METHODOLOGY, CONTEXT, AND METHODS

In this chapter I explicate the decision points associated with the design of this study. My use of and rationale for the ethnographic methods that informed participant selection, data collection and data analysis will be explained. In addition, I describe the context of the study, the participants, and the limitations of the research design.

Research methodology and methods

As Denzin and Lincoln (2005) describe, “Qualitative research is a situated activity that locates the observer in the world” (p. 3). In order to justly serve this paradigm, qualitative methods should be used to accurately depict the interpretive, iterative, and dynamic actions occurring around the phenomena being studied. Qualitative researchers do not seek to understand variables in isolation, but instead examine the variables in their natural context without manipulating them. Therefore, qualitative researchers will interpret phenomena from the vantage point of the participant (Glesne, 2006) and let patterns emerge from the data.

Due to my orienting frame, I view learning and identity as fluid and dynamic; what counts as science to one community is an empirical question, as is the performance of identity. Therefore, I chose to utilize an ethnographic approach in order to capture what the group communicates and what I see as a participant observer, outside of the group’s accessibility. Using ethnographic methods required longitudinal observations and, at its best, participant observation techniques to report on the shared culture between the researcher and participants (Geertz, 2000).
By being in the science classroom throughout the year, I had a better sense of the language, interactions, behaviors, and practices among the kindergarteners and the teachers within the culture of the classroom. Wolcott described in his book, *Ethnography: a Way of Seeing* (1999), that a study with ethnographic perspectives “provides a rich database for further research and results in a contribution to knowledge” (p.61), and that was what I hoped to gain by choosing this perspective.

Studying science learning and practices requires an understanding of what it means to learn and practice science. Becoming a member of a scientific field requires knowledge of the practices, and meanings associated with these practices when becoming scientifically literate. Members within this community construct cultural meanings that identify them as such. Latour and Woolgar denoted “science in the making” is defined by the developing and evolving social processes of its members (1986). In consideration of that and the above, it was imperative to be able to uncover patterns when viewing reform-based science practices in order to situate the new phenomena among the participants in the classroom. By researching the practices associated with evidence-based science explanations in the classroom, I was able to distinguish among the positioning of the girls amid these practices, as well as their authoring within these practices.

Employing ethnographic methods makes these local interpretations central to the analysis. As Bucholtz commented, “Gender does not have the same meanings across space and time, but is instead a local production, realized differently by different members of a community; thus an ethnographic orientation yields particularly fruitful results for language and gender research” (1999, p. 210). As this study highlights similarities and differences among kindergarten girls participating in classroom science instruction that is focused on explanation and evidence, the ethnographic methods used helped provide me with a more local understanding of the context.

Due to the rich context, data, and interactions in the science instruction in the kindergarten classroom, I utilized ethnographic methods along with case study design to
showcase the product of the ethnographic research cycle. Yin (2003) defined a case study as an investigation of a phenomenon (for my study, developing scientific identity among the girls), which occurs within an authentic context (in an evidence-based, explanation-building science kindergarten classroom) (p.13). My goal being to gain insight into how girls participate within this context. This case study approach was also chosen as it related to the theoretical framework of this research study. Drawing from sociocultural theory, the central theoretical constructs of the study are identities-in-practice and positioning. It would have been difficult to provide clearly delineated findings based on only one of the constructs due to the connectivity that they have with each other. I felt the case study approach supplied the whole picture of the phenomenon and the context in the study.

Drawing from sociocultural perspectives, the classroom, with its own culture, produced its own discourse through interactions among participants and between participants and the environment. The histories of the participants, the school community, and the mediating artifacts surrounding the participants in their environment can affect the culture of the classroom. For this reason, the study was concerned with the contextual understanding of evidence-based, explanation-building science instruction and the authoring and positioning of girls in relation to their developing identities-in-practice in this environment. Yin mentioned the case inquiry approach as it relied on multiple sources of evidence, where data is triangulated to provide rigor and in-depth analyses. I used the case study approach to collectively narrate the story of four girls within the classroom science instruction that is focused on explanation and evidence. Using ethnographic methods helped to illuminate the case studies of the girls as I investigated the co-construction of the norms in the classroom instruction that is focused on explanation building and evidence and how the girls’ authoring and being positioned as learners within the normative view of the classroom either supported or conflicted with their developing identities-in-practice.
Context of the study

The school district and the neighboring university collaboratively work together in a Professional Development School (PDS) partnership. In the PDS, university faculty and school district faculty work to bring research-based initiatives to the elementary education majors who choose this option for their field-based experiences. The undergraduate students who elect this site are called interns, and the classroom teachers that support them are called mentor teachers. The interns elect to give up the university calendar for the year and follow the school district calendar. The interns have an intensive semester of fieldwork, methods’ classes, and seminars to attend during their first semester in the program. During their second semester in the program they take on more accountability in the elementary classroom, conduct an investigation into their own inquiry, and continue to attend seminars. The mentors act as guides, facilitators, and partners for the interns as they proceed through the school year. Members of the PDS community had a variety of professional learning opportunities available to them on a yearly basis. Some of these opportunities included professional development workshops and classes offered by university faculty.

Video study group situated in CER

During the 2010-2011 and 2011-2012 school years a video study group was provided for interested school district members, which was situated around the tenets of a community of practice (Lave & Wenger, 1991). Members of the community worked with a university faculty member (my advisor), colleagues and graduate students, myself included, to implement reform-based practices, specifically, the use of a coherent content storyline to plan for science instruction.
that involved building explanations from evidence. The CER framework (Zemba-Saul, et al., 2013) helped provide the teachers in the study group with a template for designing, implementing, and analyzing science instruction. After the teachers recorded video of themselves teaching portions of the CER framework, they brought the video back to the study group and members viewed, discussed, and reflected upon the lessons. Members of this learning community also reviewed book chapters that were being prepared during this time and participated in the recording of the videos for the book written by Zemba-Saul, McNeill, and Hershberger (2013).

Gaining Access

During one of the video study group sessions in the 2010-2011 school year, my advisor asked if there was anyone in the group that I thought would be a productive collaborator for my study. There was one early elementary teacher engaged in the study group and working on strategies from the book. She worked in kindergarten, which aligned with my desire to study young girls’ learning in science. In 2008 she had participated in a research study in which she, an intern, and university researcher used the four strands of proficiency in science\(^1\) (Duschl, et al., 1997) to plan and implement lessons in a plant unit focused on seed growth. This teacher was also involved with a different university faculty member who was the parent of a child in this class the following year, where the same unit was reviewed and revised, and emphasis was placed on collecting observable evidence using photographs when applicable.

\(^1\)The four strands of scientific proficiency are outlined in *Taking Science to School* (Duschl, Schweingruber, & Shouse, 2007) and include: 1. Knowing, using and interpreting scientific explanations of the natural world. 2. Generating and evaluating scientific evidence and explanations. 3. Understanding the nature and development of scientific knowledge. 4. Participating productively in scientific practices and discourses. Additional information regarding this research endeavor can be found by accessing the following publication; Smith, Remy & Cowan, (2009).
During the 2010-2011 school year I went into Caroline’s\textsuperscript{2} classroom to video record some of her lessons for her. By the end of the school year, she and I were planning her last science unit together, focusing on explanation building with evidence in the context of instructions on seed growth. As I was the third university researcher to help Caroline with this unit, she already had a good grasp on what she was trying to implement that year. Caroline and I conducted the investigation with her students, and I was thinking about my dissertation study and contemplating whether Caroline’s classroom might be a potential site for my study. After witnessing her desire to implement reform-oriented science practices in her kindergarten classroom I asked if she would be willing to work with me during the 2011-2012 school year.

Caroline and I met over the summer before the 2011-2012 academic year and talked about my research questions and why I wanted to be in her particular classroom. We discussed my involvement with the class as a qualitative researcher, and more specifically as a participant observer (Spradley, 1980). I told her about my desire to be in the classroom from the beginning of the year and that I would like to spend the whole day there for a week or two. She was willing to allow me to bring a video camera into her classroom (with IRB\textsuperscript{3} and school district approval), to video record her and her students throughout the year. We spent some time talking about lesson planning and implementing lessons. She eagerly asked me to be a part of the lesson planning and lesson implementation. I agreed to help with whatever she wanted me to do for her.

Gaining access into the actual classroom community was something that I knew had to be negotiated with the students and other teachers in the space. I met with the intern, Taylor, before my first day in the classroom and described my study to her and what my participation might look like in the classroom. I asked her if she would like to participate in the study and she agreed. On

\textsuperscript{2} Pseudonyms have been used throughout the study to protect participant identity.

\textsuperscript{3} Permission was received by the Office of Research Protections (ORP) for this study (#37551), and informed consent documents were sent home to all participants.
this and many following occasions, I paused or took some time to check-in with Caroline and Taylor, asking them if I was in their way, or if they needed me to sit somewhere else or change the way I helped the students. Each time we had a chance to talk, Caroline and Taylor were excited to have me there and expressed their appreciation for my help.

Gaining access with the students did not take as long as I had expected, but did fluctuate in authenticity over time. The best way that I can explain the changes that occurred is to begin with defining my role as a participant observer in the kindergarten classroom.

**Participant observer**

A participant observer (Spradley, 1980; Geertz, 1973, 2000) “learns” the culture by being ensconced in the culture, i.e., looking for meanings of science and practices associated with science in the setting and girls’ participation within and against these meanings. As Spradley (1980) explained, a participant observer may learn from cultural behavior, cultural artifacts, and speech messages used by the participants within the community throughout their daily activities. The goal of participant observation is to observe with direction, while allowing for new patterns and practices to unfold and to be able to zoom in and zoom out throughout the process in order to achieve a more complete analysis of the culture.

During participant observation, I was involved in the context of the classroom in different roles. One role was as researcher, which included observing what was taking place, taking ethnographic notes, asking follow-up questions, and recording classroom discourse. The other was as participant, which involved observing, working with and being a part of the culture that was being studied. As these are two separately challenging roles, my involvement in the class as a participant varied throughout the year. At the beginning of the academic year, I was introduced by Caroline as a student at the neighboring university, as a science teacher, and as a researcher.
When I was present for class, I participated as a member of the class, sitting near the students, either on the carpet or on a chair nearby. When I was not able to make it to class, Caroline asked the students to retell me what happened in my absence to fill me in on the work that they had discussed. If students asked questions during whole group discussions, I would defer to Caroline, but if she needed my help with answering their questions I would help. If a student asked me a direct question, I would answer them.

At first, I was very involved in participating, but over time, as my study progressed, I pulled back my participation, as I was having a difficult time operating my research tools, recording my observations, and hoping to maintain an emic stance (Kottak, 2006). I began to observe from the periphery, not sitting on the carpet but sitting a few feet back at a table. I held my ethnographic notebook in my lap and my camera was positioned nearby. I still participated in whole class science talks, small group explorations, and individual science notebook sessions, and I walked throughout the room asking questions of students about their work.

**My own bias**

Because this study examines the practices and knowledge building associated with science instruction that is focused on explanation-building with evidence, the “practices, roles, and positions do not come to students automatically as they might in the prototypical figured world of school science learning” (Carlone, et al., 2011, p.482). Therefore I needed to be vigilant, maintain consistency, persistence and endurance when I observed and participated within this environment in order to analyze patterns and interactions among the participants. I needed to unlearn what was the norm in my mind and find value in asking, “What counts as science and science identity in this setting” (Kelly, Chen, & Crawford, 1998)? My bias is grounded in my own experiences, my identity, and my desire to see young girls have access to classroom science.
instruction focused on explanation building with evidence. My bias for what counted as science could have overshadowed or filtered what I observed and recorded, unintentionally, because of my experiences in various classrooms, or with my own children. This was a difficult hurdle to face, as I struggled with allowing the study to be ethnographic and not limited by my views, while succumbing to the needs of the teachers.

Caroline and Taylor would frequently ask me if they “did something correctly” or “should we have X,Y,Z instead of A,B,C,” seeing me as an expert because of my involvement in the previous video study group, being a university researcher and teacher, and having instructed students in science for ten years previous to this study. Taking on the “expert” role, however unintentional, still created a power dynamic that existed in this space. Seeing me as an expert may have supported the instructional context within the classroom, as Caroline and Taylor asked for help with content and connection to instructional techniques associated with CER. I was able to co-plan with them and discuss and reflect with them after they taught a lesson or two, so even the lesson designs may contain my bias. However, they did not ask me about the identities of the girls, or whom they should call on, or where they should have the students sit in the classroom. Other than speaking with them about ideas within my notes, our conversations were predominately about the science instruction in the classroom. Another area of concern was the presence of the video camera in the classroom. I introduced the camera as a way to collect information about what the students were saying, and as a way for me to go back to the classroom activities of the day so that I could remember what we did in class, but it did have its own presence in the classroom and may have affected the participation and interactions of the participants. In the same vein, my pulling certain students into the hallway to talk with them and show them video throughout the year may have affected their participation in the class, as well as other’s participation and interactions when they were not chosen to go out into the hallway with
me. I tried to combat this situation by adding additional videotaping sessions with all students, and compiling an end-of-the-year video for each child showcasing their learning in science.

Research site

The school where Caroline worked was a small public elementary school located in the northeastern part of the U.S. The school contained grade levels K-5 and there were three kindergarten classrooms in the building the year that the study was completed. Approximately 20-23 students, one teacher, one paraprofessional and typically an intern occupied each kindergarten class. The school day was six hours in duration, 8:50 am-2:50 pm.

Participants

Caroline’s classroom contained 23 students; 9 girls and 14 boys. The demographics of the class were not racially or culturally diverse, with 21 Caucasian students, one Asian student, and one Arabic student, ages five to six years old. Within the first few months of the school year the Asian student withdrew from school and returned to China, the Arabic student changed schools due to family relocation and one Caucasian student withdrew to be homeschooled, leaving 20 students for the majority of the school year. Three of the students, two boys and one girl, did not elect to be in the study, so the study was informed by 17 students, one teacher, one classroom intern, two paraprofessionals, and myself.

Out of these 17 students, four were chosen to inform the case studies. Molly, Josie, Olive, and Daphne were chosen for a more in-depth data collection because of how they presented themselves during the first three months of the school year. After participating in the classroom as an observer and participant, I was able to see how the interactions were happening among the
girls in the class. Molly and Daphne stood out to me in whole group settings as eager to participate, thoughtful with their writing and/or drawing in their science notebooks, and engaged in class (ethnographic notes, 11/18/11). Olive and Josie struck me as almost the opposite of Molly and Daphne. Olive was quiet, reserved, and appeared to be contemplative. Josie was free spirited and wanted to sit near her friends all of the time. She did not participate as readily, but at times, she tried to answer Caroline’s questions. I wanted to have four different starting points of participation when looking at girls’ access to science instruction in this space because I wanted to have as many beginning and varied views to observe and research as I was able to thoroughly capture and analyze. After these four were chosen as the four participants that I followed more closely, I began to take more detailed notes on their interactions and participation with the class.

**Data sources and collection methods**

Due to the use of ethnographic methods the following approaches to data collection were chosen for this study: video recording of student discourse, student interviews, ethnographic field notes, photographs of student science notebooks and additional artifacts, teacher informal interviews, and a parent/guardian questionnaire.

I began my data collection after I went through the proper approval channels with my university and the participating school district. In August 2011, I submitted an IRB request for approval for the study (Appendix C). After IRB approval (Appendix D) my advisor presented my study at a school board meeting and asked for their approval. The school board approved my study and asked that I report back the results when the study concluded. During Back to School night, I presented the plans for my study to the parents and guardians of the students in Caroline’s classroom. I also stayed in the classroom to answer and questions or provide more explanation if needed. The following school day, Caroline sent home study packets with all of her students in
their Friday folder, which contained informed consent forms and envelopes to send back in to me. After the consent forms were processed and participants were consented, I began to collect my data.

I collected most of my data as a participant observer for a total of 9 months – approx. 53 kindergarten classes, from September 2011 to May 2012.

**Video of student discourse**

The students’ discourse and interactions in the classroom provided primary sources of data for my study. The actions, dialogue, interactions, and interpretations of the students in the classroom were captured on video and provided me with a rich data source for examining authoring, positioning and norms of participation within the classroom science instruction of explanation building with evidence. From my video files and field notes I developed a log summarizing the daily science topic, specific activities, video file name, length of clip, and additional notes. A screen shot of part of this log can be seen in Figure 3-1.
Figure 3-1: Example of log of field notes and video files where I logged all video files, date of capture, time of day, focus of lesson, type of activity, name of video file, length of video file, usefulness to RQs, has the four girls, and comments.

Video was the most abundant source of primary data collected and as such, was used as a source of triangulation during analysis (Kelly, et al., 1998). A single video camera equipped with a microphone was used each day and moved from location to location by myself when the classroom setting shifted or when students were asked to move into other arrangements. I also used the camera to video tape the students when they were outside of their classroom. Video was taken of multiple events including, classroom science lessons, small group interactions within the science lesson, one-on-one discussions with students inside and outside of science class, and discussions with teachers. Video data is important because it allows for repeated interpretations and allowed me to gain access to another viewpoint (Stake, 1995). Figure 3-2 shows the timeline of this data collection over the duration of the study and Figure 3-3 shows the amount of hours spent on science instruction throughout the study. Initial visits to the classroom were not videotaped because students had not been consented until mid-September. The initial video
recordings were of everyday practices in the classroom because I wanted to document the ways that students practice everyday life in their classroom (Kelly & Chen, 1999). Data collection video files were recorded on 53 visits, resulting in approximately 28 hours of video data being collected.

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<td>7</td>
<td>29</td>
<td>20</td>
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<tr>
<td>12</td>
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</tr>
</tbody>
</table>

Figure 3-2 Timeline of days in the classroom of science instruction

<table>
<thead>
<tr>
<th>Month</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total recorded hours</td>
<td>0</td>
<td>0.2</td>
<td>2.16</td>
<td>3.13</td>
<td>0</td>
<td>6.71</td>
<td>3.42</td>
<td>1</td>
<td>4.1</td>
<td>4.2</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 3-3: Timeline of the amount of hours spent on science instruction

**Student interviews**

Interviews were chosen as a way to recount prior events, and to further my understanding of the thoughts and actions taken by students and teachers. In ethnographic interviews, because the interviewer and interviewee already know each other they may proceed cautiously, but with less angst than if the interviewer was not familiar with the participants and the context (Spradley, 1980). Student semi-structured interviews occurred two times during the year (February and May), and were video recorded. The interviews consisted of asking students questions about the unit of study and their thoughts about science and scientists. The interviews contained a few prompted questions, manipulatives, exploration about the phenomenon of study, and unstructured time. There were also three additional interviews conducted of each case study participant during
the latter part of the year. During these interviews, I asked the girls to watch a clip of a previously recorded classroom science lesson from their kindergarten class to recount their thoughts and actions during the clip. An example of the questions that I asked can be found in Appendix E.

Gathering this first-hand account of the actions and dialogue seen on the video provided me with a richer sense of the dynamic nature of the video clip and provided additional data with which to construct an explanation and answer the research questions in the study. In addition, it allowed the student to talk about their positioning and authoring within the context of the video clip, providing me with an explicit account of students’ feelings and thoughts, which would not have been “visible” otherwise. Students were also asked about their perceptions of what science is, who can be a scientist, and what the practices of science are. Realizing that this account may also be interpretive in nature, I not only relied on one account from each context, but on multiple accounts, trying my best to triangulate the data.

**Ethnographic field notes**

Finally, as a participant observer (Spradley, 1980), my ethnographic field notes served as an abundant primary source of contextual data, Figure 3-4. I was present in the classroom throughout the study, interacted with teachers and students, administrators, and at times, parents. Observations were made continuously throughout the study and served as a primary source of data as Yin (1994) suggested the importance of observation as providing a detailed picture of the case by supplying evidence for the study.
While I was in the classroom I took field 176 pages of field notes over 55 days (Emerson, Fretz, & Shaw, 1995), which I expanded upon at other times, in response to what Geertz denotes as “thick description” or “cooking the notes”(1973). While jotting down notes in a stream of consciousness writing method, I was only able to include a minimal amount of detail and writing, even though I knew I should be taking the time to write the field note with as much detail and description as possible. At times, I was involved in the events of the classroom and could not take extensive notes. I wrote all of my field notes in a notebook, using the margins as a place for recording the time and memos. At times, my notes included diagrams, listings and charts that I made to record the classroom setting, if I wanted to take specific notes about student placement, daily agendas, and actions. While I was cooking the field notes, I typed them into a dissertation notebook section, which I created on my computer. Many of the notes I took were observational and I tried to use as much verbatim language as I could.

When I typed the field notes, at a later date, I added my personal thoughts and connections to theory, asked questions, included thoughts to bring up with Caroline and gave more specific titles to sections within the notes, such as searching for evidence, planting seeds, etc. As my time in the classroom progressed, my field notes began to change as a result of the
ethnographic process. I began to take more focused notes, concentrating on words and actions 
used during science talks and note booking. As I selected four girls to observe more closely, my 
notes became more refined and focused. An example of my refined field notes may be found in 
Figure 3-5.

Figure 3-5: Example of ethnographic field notes, cooked
Student notebooks and additional student artifacts

In addition to the captured video, in order to study identity, it was beneficial to consider the point of view of the students who are enacting it (Bucholtz, 1999). Therefore, I used students’ notebooks as a primary data source. Other secondary data sources that originated from the students were artifacts of their work – their constructed models, KLEW charts, data tables, graphs, and other pieces of text. Over 250 photographs were taken of each participant’s science notebook, which were then catalogued, and saved to a hard drive. Photographs were also taken of additional artifacts in the same manner. These artifacts provided additional depth into the students’ practices within the evidence-based explanation-building kindergarten science classroom. I used these artifacts to help me build my case studies and analyze my ethnographic methods by using multiple points of comparison in eliciting thematic analysis. The questions that I asked myself when looking at student notebooks were listed below:

Date of entry:
Prompt for entry:
Does the student answer the prompt completely?
Does the student write and/or draw to answer the prompt?
Does the student add additional information or questions to the notebook entry that was not asked of them?

Teacher interviews and artifacts

Caroline and Taylor provided extremely helpful data. Occasionally, we talked while the students were at recess or at a “special” and exchanged information about the day. We also talked after class, when time permitted, about the day’s events and what I noticed from my ethnographic notes. At times, Caroline or Taylor would adjust their pedagogy due to the conversations that we had or adjust the assessment strategy that they were using. For instance, on

4 A “special” is a period of time in the students’ day in which gym, library, music, or art is taught.
a few occasions after we shared information with each other about the day, I was able to tell them what questions students had while I conducted their mid-unit interviews. Caroline took this information and changed her plan for assessing the students. Instead, she used the interview answers to give a summative assessment of the students and planned her future instruction based off of the work I completed with the students.

In addition, I conducted semi-structured interviews with Caroline and Taylor in the classroom. I occasionally showed them video clips of classroom interactions and asked them to discuss with me what they saw occurring in the clip. During the teachers’ interviews I also asked them about their perceptions of science, who scientist are and what they do, and about students’ participation and positioning in the classroom. I chose interviews as a data collection method because I wanted to have participants recount prior events, thereby furthering my understanding of the thoughts and actions taken by the girls and the teachers.

Teacher artifacts also helped to provide me with a more detailed understanding of the setting and procedures that occurred within the classroom. These artifacts included lesson plans, content storylines, seating charts, daily plans and e-mail correspondence between myself and Caroline (Appendix B), and were considered tertiary data sources as they helped to inform my understanding of the context in the study. We planned science lessons bi-weekly. Our sessions included a 20-45 minute block of time wherein we constructed or reviewed the coherent content storyline for the upcoming unit or the unit that was simultaneously being taught. Throughout our planning sessions, we discussed observations that were made concerning the students and the curriculum from the past week in order to modify and/or adjust our intentions for the following week.
Parent/guardian questionnaire

The parents and/or guardians of the students provided me with background and demographic data concerning their children in the form of a questionnaire (See Appendix A). This questionnaire was used as a secondary data source to inform my analysis of the participants’ identities-in-practice. This data helped me elicit a more in-depth understanding of the students’ interests inside and outside of school, which was useful in building rich case studies of girls in the science classroom. Caroline sent the parent questionnaire home in the student’s Friday folder with an envelope for the parents to return it in. I received thirteen of the seventeen questionnaires back from the parents. I was able to gather anecdotal data from the questionnaires, which helped me to build my cases for Molly, Josie, Olive, and Daphne.

When thinking about my research questions, theoretical framework, and data sources, I found the following chart to be helpful in guiding my data collection and phases of analysis, see Table 3-1.
Table 3-1: Research design matrix of questions, data sources, analysis methods, and theoretical frameworks

<table>
<thead>
<tr>
<th>Research questions</th>
<th>Data sources</th>
<th>Data analysis</th>
<th>Theoretical framework</th>
</tr>
</thead>
</table>
| 1. How are the norms of participation co-constructed within Caroline’s kindergarten classroom? | - 19 days of classroom observations  
- 44 pages of ethnographic field notes  
- Artifacts of student work, science notebooks  
- Over 5 hours of video data, and transcripts of classroom activities from first two units | - Ethnographic Research Cycle (Spradley, 1980)  
- Construction of event maps (Kelly & Chen, 1999)  
- Selective coding of field notes (Emerson et al., 1995)  
- Constant comparative analysis (Strauss & Corbin, 1998) | Communities of practice (Lave & Wenger, 1991)  
Sociocultural learning and situated learning (Greeno, et al., 1996) |
| 2. How are kindergarten girls authoring themselves (as science learners) within this classroom? | - 53 days of classroom observations  
- 176 pages of ethnographic field notes from classroom discourse  
- Over 11 hours of video, and transcripts of Light and Shadows unit  
- Over 250 photographs from students’ science notebooks  
- 5 sessions of formal student interviews  
- Informal interviews with teachers and teacher artifacts  
- Parent questionnaire | - Ethnographic Research Cycle (Spradley, 1980)  
- Construction of event maps (Kelly & Chen, 1999)  
- Selective coding of field notes (Emerson et al., 1995)  
- Constant comparative analysis (Strauss & Corbin, 1998)  
- Identity Discourse Tool (Gee, 2011)  
Identity work (Wortham, 2006), Discursive identity (Brown, Reveles & Kelly, 2005)  
Communities of practice (Lave & Wenger, 1991) |
| 3. How are the kindergarten girls positioned (as science learners) within this classroom? |                                                                                   |                                                                              |                                                                                        |
| 4. What are the girls’ developing identities-in-practice in this classroom?         |                                                                                   |                                                                              |                                                                                        |
Influences on instructional context of the study

The classroom and the school provided structure to the activities that were experienced by the teachers and students. Artifacts from the classroom and school provided me with curriculum, daily routines, seating arrangements, and course of study documents, which were valuable in describing the setting and context for the study. Understanding the structure of the school, the school schedule, among the classroom structure and classroom schedule allowed me to position activities against time frames, and to analyze the teachers’ role and students’ roles within these systems. Being able to analyze the classroom and school structure helped me to understand the pressures being put on elementary teachers and students, and add to the explanation of setting science norms against other disciplines within the same classroom.

Curriculum

The curriculum was school district written, informed by curricular coaches and other interested parties, and contained the following themes for science and social studies: All About Me, Human Body, Senses, Color, Light, Sound, Nutrition, Bears, Winter animals and their habitats, Plants, Insects, and Transportation. In the year of this study, Caroline was mainly focusing on Light, Sound, Plants, Human Body, and Senses. Caroline, Taylor, and I restructured the units so that they did not stand alone and our final units were named: Introduction to science practices (Senses), Changes in self and the environment (Human Body, Nutrition, Senses, Plants, Winter animals), Sound, Light and Shadows, Living and Nonliving things (Plants, Senses).

This chart below, Figure 3-6 depicts the days of recorded curriculum coverage by unit in Caroline’s kindergarten classroom during the study.
The first two units, Introductory unit and Changes in Body and Environment, were used to inform Chapter 4, the norms of participation because they were the first two units that the kindergarteners had exposure to in this context. These two units occurred during September, October, and November, mainly. The Changes in Body and Environment unit spanned the school year, but had the majority of its instruction in the beginning of the school year. The third unit, Sound, was totally taught by Taylor as part of her method’s assignments. She was instructed to teach a three-day unit focusing her instruction on CER. This unit was not analyzed because Taylor was a novice in teaching with using the CER framework and I felt that would impact the results of the study because I was researching a teacher in the other units that had experience with CER. While Caroline was not an expert, she was not at the same novice level as Taylor. The fourth unit was the Light and Shadows unit (Appendix B) and this unit was selected for intensive
study of the four case study girls because it was a new unit for Caroline to teach using CER. I selected this unit to focus on because I wanted to see Caroline use her CER knowledge, with my help and Taylor’s help, with a new content area that was not as familiar to the students as the following unit of Living and nonliving things. The Living and Nonliving things unit, that contained a large objective of studying plant growth and requirements for plant growth, was a unit that Caroline had worked on in the past with two university instructors and children historically are more familiar with the content.

Phases of analysis

Phase one: Coding initial observations and looking for patterns of science discourse

Initially, I made “grand tour” observations (Spradley, 1980) while I viewed the classroom for the first few days. I used this time to become familiar with the environment and the people in the environment. I began to look for features that Spradley referred to as the major dimensions of every social situation (1980, p. 78). These dimensions include space, actor, activity, object, act, event, time, goal, and feeling. I used my journal as a place for reflexive practice, as well as a place for field notation. My field notes (Emerson, et al., 1995) accompanied my observations and were expanded upon in response to what Geertz denotes as “thick description” or “cooking the notes” (1973). This allowed me to include audience and stance within my renderings of what occurred in the classroom during the day.

In order for me to begin the process of analysis, I needed to start with my questions to look at the practices within the kindergarten classroom that occurred during science time.

1. How are the norms of participation co-constructed within Caroline’s kindergarten classroom?
2. How are kindergarten girls authoring themselves (as science learners) within this classroom?

3. How are the kindergarten girls positioned (as science learners) within this classroom?

4. What are the girls’ developing identities-in-practice in this classroom?

Using Spradley’s Ethnographic Research Cycle (1980), I began to investigate my overarching question, see Figure 3-7.

Figure 3-7: Example of my use of the Ethnographic Research Cycle
Throughout this process I continued to ask questions of my data, created representations of my data and interpreted my representations, also known as constant comparative analysis (Strauss & Corbin, 1998). While doing this, my interpretations and the data led to new questions and new insights, that shows how the process is iterative and allowed me the opportunity to zoom in and out of the scope of analysis. I zoomed in to look at specific interactions and zoomed out to look at the structures surrounding those interactions.

I began to create event maps in my computerized data log informed by class observations, video files of classroom discourse, and my ethnographic notes. From these event maps I was able to see patterns emerging from the data. In my first round of coding, I coded for talk moves that were being used to facilitate the science class by Caroline, Table 3-2.

Table 3-2: Codes used for analyzing talk moves from first two units

<table>
<thead>
<tr>
<th>Talk Moves</th>
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</thead>
<tbody>
<tr>
<td>Revoicing</td>
</tr>
<tr>
<td>Asking students to restate someone else's reasoning</td>
</tr>
<tr>
<td>Asking students to apply their own reasoning</td>
</tr>
<tr>
<td>Applying reasoning to someone else</td>
</tr>
<tr>
<td>Prompting for further participation</td>
</tr>
<tr>
<td>Asking to explicate reasoning</td>
</tr>
<tr>
<td>Using wait time</td>
</tr>
<tr>
<td>Using the phrase agree or disagree</td>
</tr>
</tbody>
</table>

I coded these talk moves in my ethnographic notes, my informal interview notes, and from observations. I also began to code for Caroline’s use of terms associated with science
practices coupled with her talk about what scientists do. Those codes were as followed in Table 3-3.

Table 3-3: Codes for science practices or what scientists do when they are working.

<table>
<thead>
<tr>
<th>References to what scientists do</th>
<th>Thinking</th>
<th>Drawing</th>
<th>Sharing</th>
<th>Writing</th>
<th>Problem solving</th>
<th>Question solving</th>
<th>Showing/Demonstrating</th>
<th>Finding evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using tools</td>
<td>Using tools</td>
<td>Working</td>
<td>Wondering/Questioning</td>
<td>Listening</td>
<td>Talking</td>
<td>Using a science notebook</td>
<td>Observing/Noticing</td>
<td>Gaining knowledge from evidence</td>
</tr>
</tbody>
</table>

Again, these were coded from the previously mentioned data sources and analyzed using the same methods mentioned above. After I developed codes to help with analyzing my first research question, I began to develop codes for the rest of my questions. At this point in my analysis, I had not yet chosen the four girls that would be studied in greater depth, so I began compiling a list of descriptors to characterize what I was observing and writing about in my journal. The beginning words I used when thinking about the girls in the class were eager, shy, unwilling, helpful, overly zealous, questioning, sharing, showing, off-task, consistent, and persistent. It was from this list, my notes in my journal, observations in class, and teacher informal interviews that I chose Molly, Josie, Olive, and Daphne.
Phase two: Transcription, detailed event maps, and coding

After I felt that I had an understanding of the routines and practices that I was observing in the classroom, I began to get more detailed with my analysis. I began to ask how frequently was I seeing some of the practices emerge, and asked myself, were there patterns in the data? One of the most important forms of analysis in this study relies on discourse and was represented in the form of transcripts. My transcripts are organized by line, time, speaker, message unit, and nonverbal actions. An example of a transcript can be seen in Figure 3-8. Message units are delineated by boundaries of utterances or social actions, and are the smallest linguistic unit (Kelly & Crawford, 1996). These message units are denoted by pitch, stress, fluctuation in speech, pauses, and intonation (Gumperz, 1992).

<table>
<thead>
<tr>
<th>Line</th>
<th>Time segment</th>
<th>Speaker</th>
<th>Discourse</th>
<th>Nonverbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0:00:00</td>
<td>jc</td>
<td>We see this lightbulb</td>
<td>pointing to lightbulb in KLEW chart</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>jc</td>
<td>that's where we wrote down</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>jc</td>
<td>the things that we</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>jc</td>
<td>learned</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>jc</td>
<td>that lightbulb went off</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>jc</td>
<td>and we said</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>jc</td>
<td>oh</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>jc</td>
<td>I just really learned this</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>jc</td>
<td>and I know for sure that that's what happened</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>jc</td>
<td>scientists call that a claim</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>jc</td>
<td>we can claim that something happened</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0:00:20</td>
<td>jc</td>
<td>then these eyes</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>jc</td>
<td>were what?</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3-8: Example of a transcript with message units

After I prepared the transcripts with message units, I printed the documents and analyzed the transcripts for actions units by hand. See Figure 3-9 for an example of what the analyzed transcripts looked like. Action units show a relationship between message units and represent an observed intended act by the speaker (Kelly & Crawford, 1996). I then looked at the relationship between action units of connected speakers, which I labeled interaction units. These interaction units showed the interactions between speakers and were used to show how the interactions in the
space connected to show sequence units and ultimately events and cycles within this kindergarten classroom.

Figure 3-9: Analyzed transcript with actions units
After I was finished typing the transcripts, I put together more detailed event maps that included sequences and interaction units. An example of an event map can be found in Figure 3-10.

**Cycle: Exploring the construction of different shadows using a block and discussing findings (1/26/12)**

1. **Event:** Preparing students with directions, object, NB set-up for independent work with block and tracing shadows (6min 35 sec)
   - **Sequences:**
     - Introduction of task of placing block on hand to observe
     - Interruption behavior redirect
     - Giving directions for task of holding block
     - Interruption behavior redirect
   - Looking for shadow of block in hand while students observe and look for theirs
     - Giving directions for the next task; NB directions
     - Clarifying directions for those who are unsure
     - Checking in with students as they work

2. **Event:** Teachers walking around and discussing observations with students in small groups/independent work time with blocks and shadows (1min 45 sec)
   - **Sequences:**
     - Discussing observations with small group of students
     - Revise directions for NB to include writing and not just drawing

3. **Event:** Discussion of observations of block and shadows and manipulating the block to see different shadows (2 min 20 sec)
   - **Sequence:**
     - Discussing observations of different shadows

Figure 3-10: Example of an event map from the Light and Shadows unit

Within this event map, the sequences of actions are delineated and times are associated with each event. Looking at the event maps helped me to re-analyze the norms of practice within the science classroom by looking for specific phrases and events that happened in patterns. After specific phrases were identified, I made a table to calculate the different practices that were occurring in each curricular unit, so that I could compare the practices being used in each of the units where Caroline was co-constructing the norms in the science classroom with the students. An example of these phrases can be seen in chapter 4, and an example of the coverage of practices among units can be found in Table 3-4.
Table 3-4: Science practices (codes) across analyzed units

**Disciplinary practices, Kindergarten version**

<table>
<thead>
<tr>
<th>Disciplinary practices</th>
<th>Introductory unit</th>
<th>Changes unit</th>
<th>Light and Shadows unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Measure</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Investigate</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ask questions</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Use tools</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Display information (KLEW)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Record in notebook</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Communicate ideas in science talk</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Use evidence to co-construct claims</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Phase three: Deeper analysis of interactions and discourse patterns**

Using this Light and Shadows curricular unit, I wanted to examine the four case study girls’ participation with whole group science talks and individual science notebook work. I began by analyzing the interactions among the girls, Caroline, and the class. It is from there that I developed tables to visualize the interactions (Figure 3-11) occurring between the members in the school science community. I noted each member that began the interaction and whom they had the interaction with, e.g. Caroline/Molly could be read as Caroline began the interaction and she interacted with Molly. I developed graphs to depict interactions for the entire Light and Shadows unit (Figure 3-12) and the interactions of the four case study girls from the Light and Shadows unit (Figure 3-13).
Figure 3-11: Sample of the interactions chart I made to visualize all of the interactions in the Light and Shadows unit.
Figure 3-12: Graph of the interactions of case study girls throughout the Light and Shadows unit.

Figure 3-13: Graph of the total interactions in the Light and Shadows unit.
Evidence from similar studies similar to this one in theory (Barton & Tan, 2010; Brickhouse & Potter, 2001; Carlone, et al., 2011; Carlone, 2004; Carlone & Johnson, 2007; Tan & Barton, 2007a, 2007b) suggested the need for close examination of the discourse processes and contextual activity within the classroom to help identify the positioning and participation reflected by the girls in the study. Within this context, I examined the nature of and responses to the girls’ bids for recognition (e.g., when they did so, for what reasons, from whom they bid) so as to draw inferences from evidence about how the structures surrounding the girls helped or hindered their positions in science, what they deemed important enough in order to get recognition, whose recognition mattered to them, and the ways their teachers and peers responded (Carlone, et al., 2011). Being cognizant of the call for research from the mezo-level (Shanahan & Nieswandt, 2011), this research supports the collection of data and analysis across this local level of development in student participation and model making (Carlone, et al., 2011; Olitsky, et al., 2010).

Researchers distinguish between random actions and the development of identities by locating the repetitive patterns of the spaces in which participants author identities. This pattern would not be present in random acts, which would not contribute to the authoring of these identities within the community of the science classroom (Barton, et al., 2008). The choices girls make when they are participating within the scientific community reflects the ownership or lack of ownership of their scientific identity (Barton, et al., 2008).

After I looked at the interactions occurring within the unit, I needed to take another pass at the transcriptions from the Light and Shadows unit to open code for scientific practices among the case study girls. As I open coded for practices of science, I also used Gee’s “Identities Building Tool” (2011). The “Identities Building Tool” helped me to “ask what socially recognizable identity or identities the speaker is trying to enact or to get others to recognize and ask how the speaker’s language treats other people’s identities, and what sorts of identities the
speaker recognizes for others in relationship to his or her own. Also, reminds me to ask how the speaker is positioning others, and what identities the speaker is inviting others to take up” (Gee, 2011, p. 110). I chose to use this tool as I coded the transcripts and my ethnographic notes for scientific literacy practices and participation markers seen in Figure 3-14. The x denotes that the participant practices the skill often (more than 5 times) in discourse and/or writing, the / denotes that the participant moderately practices the skill (5 times or less), and the O denotes that the participant did not practice the skill.
Figure 3-14: Coding phrases and practices for analysis of identities-in-practice of case study girls

<table>
<thead>
<tr>
<th>Practices of scientists &amp; ways of participating</th>
<th>Molly</th>
<th>Josie</th>
<th>Olive</th>
<th>Daphne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Measure</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Investigate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Use tools</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Display information</td>
<td>x</td>
<td>/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Record in notebook</td>
<td>x</td>
<td>/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Communicate ideas</td>
<td>x</td>
<td>/</td>
<td>/</td>
<td>x</td>
</tr>
<tr>
<td>Use evidence to co-construct claims</td>
<td>x</td>
<td>/</td>
<td>/</td>
<td>x</td>
</tr>
<tr>
<td>Ask questions</td>
<td>O</td>
<td>O</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Eager to share</td>
<td>x</td>
<td>/</td>
<td>/</td>
<td>x</td>
</tr>
<tr>
<td>Picked on to share</td>
<td>x</td>
<td>/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hand raised continuously</td>
<td>x</td>
<td>0</td>
<td>/</td>
<td>x</td>
</tr>
<tr>
<td>Hand never raised</td>
<td>0</td>
<td>/</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Volunteers to answer</td>
<td>x</td>
<td>0</td>
<td>/</td>
<td>x</td>
</tr>
<tr>
<td>Does not volunteer to answer</td>
<td>0</td>
<td>x</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Distracted</td>
<td>0</td>
<td>x</td>
<td>/</td>
<td>0</td>
</tr>
<tr>
<td>Holds the floor</td>
<td>x</td>
<td>0</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Gives up the floor</td>
<td>0</td>
<td>0</td>
<td>/</td>
<td>0</td>
</tr>
<tr>
<td>Engages other students</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Helps other students</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Helps the teachers</td>
<td>x</td>
<td>0</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Demonstrates understanding</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hesitates</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>0</td>
</tr>
<tr>
<td>Negatively answers, I don't know</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>0</td>
</tr>
<tr>
<td>Praise from teacher</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Praise from peers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Praise from self</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Notebook includes on-task answers</td>
<td>x</td>
<td>/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Notebook includes extras</td>
<td>0</td>
<td>0</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Notebook doesn't have on-task answers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Phase 4: Case studies

During the next stage of analysis I used the coded transcripts and notes that I took from the margins of the transcripts to code for phrases and actions by hand, signifying when a participant was being positioning by using the color blue, and signifying when a participant was authoring herself as a science learner by using the color pink, see Figure 3-15 below.

![Figure 3-15: Coded positioning and authoring on the transcript for one case study girl’s interactions](image-url)
After I coded the transcripts for positioning and authoring identities-in-practice, and reviewed the practices associated with science that each girl was exhibiting, I made individual webs for each case study girl (Figure 3-16). I made the webs to inform my analysis so that I could describe and visualize how the authoring of identities-in-practice and positioning for each girl was surrounding them.

Figure 3-16: Web format depicting Molly’s authoring identities-in-practice and positioning as a science learner.

After I made the webs, I reviewed the parent questionnaire data and coded the questionnaires for descriptive words about the girls’ identities-in-practice and science practices. I also reviewed the coded transcripts from the interview data that I obtained from the girls and their coded science notebook photographs and additional artifacts to include within the case study of each girl. After I
finished reviewing the data, I added new descriptions to the web. After the webs were created I started to craft Molly’s case study by using all of the pieces of data that I had analyzed. After I crafted Molly’s case study, I showed it to my advisor for review, and after a positive review, I crafted the case studies of Josie, Olive, and Daphne.

**Phase five: Cross-case analysis**

Cross case analysis was the final step I took in completing the analysis for this study. Cross case analysis facilitates the comparison of similarities and differences among the events, activities, and interactions that are the units of analyses in the cases (Stake1995). I reviewed the webs of the case study girls that I created, coded transcripts of student discourse, coded transcripts of student interviews, parent questionnaires, students’ artifacts, and my coded ethnographic notes to analyze comparisons across the cases of Molly, Josie, Olive, and Daphne. I created a table to record examples of my cross-case analysis findings (see Chapter 5, Table 5-1) and to help me characterize the comparisons that I was recording. Using the theoretical lenses of identities-in-practice and positioning, I used my analysis of the cases to craft three assertions that became evident to me as I compared the four girls’ case studies.

**Process for triangulating data from different sources**

As I showed you the analysis for each of my different data sources above, I also used these sources to help with triangulating the data. I looked through all of the Light and Shadows notebook pages for the case study girls to see if any scientific practices were highlighted in their
notebooks and if they added questions, or additional wonderings or explanations to their entries. I used the answers from the parent questionnaires to inform the case studies and to see if the parents described their children by using words similar to the identities-in-practice that their children were exhibiting. I also went back to my ethnographic notes to look for codes and descriptions that may help to inform my analysis of the case study participants. Questions that I asked of participants during science instruction and interviews came from the analysis of my field notes, having discussions with Caroline, and from my observations in the classroom.

**Validity, reliability, and limitations**

Throughout the research process I hoped to limit concerns about validity and reliability; however, I know there will be some. Creswell (2007) encouraged researchers to use triangulation as codes emerge, not just to triangulate the data, but to triangulate the codes from the data, which I have tried to do within my transcripts, ethnographic notes, and student artifacts. Another validation strategy is the use of thick description. Thick description provides the reader with a rich, dense narrative of an account, which allows for more transparency.

Generalizability of the case study method quite often comes into contention when discussing limitations of qualitative studies. My study is no exception; however, case studies lead to new ideas and detailed understanding of local conditions. These understandings will be able to be tested among other kindergarten classrooms that have similar contexts and needs for their populations.

Participant observation creates a way of making sense of the culture by being “inside” the culture; however, this also comes at a price. Being a participant observer may complicate issues of objectivity and may compromise some behaviors in the study due to the embedded nature of participation and observation. Spradley suggests practicing introspection while keeping a
reflexive journal to record both “objective observations” and “subjective feelings” (1980, p.58), which I did as I proceeded through my study and talked with Caroline, Taylor, and various members of my committee.

As Wolcott (1999) addressed his limitations within his study, I too will address mine as to lay them out for all to see in an attempt to eliminate the need to revisit them at a later time. Due to the focus of my study, girls in classroom science instruction with a focus on explanation building with evidence, and the environment in which I studied, kindergarten, I was limited in my choice of research sites. This may be problematic to some researchers, as the demographic of the research site contained a majority of Caucasians students from middle to upper class socioeconomic statuses. This site was chosen because of the teacher and grade level that I had access to and the demographics could not be changed. Plus, I was interested in young children and teachers who engage in these scientific practices with their students and teachers like this are few and far between.

As minimally discussed in the gaining access to the research context section of this study, having a space in the community may also be considered a dilemma, at times, for me due to the need to separate from the context of the community when reviewing the research, goals, and validity within the study. Spradley (1980) suggests using questions as a starting point for the participant observer that cover what people are saying, doing, and producing. In order to answer these questions, the participant observer must collect field notes, interviews, and artifacts from the field. If I weren’t in the field each day, listening to the participants and interacting with them, my understanding of the artifacts and the meaning behind their answers to my questions would have been less meaningful.

Another limitation was the use of and the perspective of the recording equipment. I used one, stand-alone video camera with a microphone built-in. This limited some of the audio that was captured and the perspective that I observed when I was watching the video to transcribe the
discourse within the classroom. I was only able to view the captured area unless I moved the camera around and in that case gave up taking as many ethnographic notes. This limitation was addressed, however, by including a triangulation of the data. I did not solely rely on video clips from the classroom to build the case studies or analyze the norms of participation within the classroom.

In the next three chapters you will read about how the norms of participation were co-constructed among the participants in the kindergarten classroom, the case studies of Molly, Josie, Olive, and Daphne, and the findings across cases with a discussion built in.
Chapter 4

ANALYSIS OF NORMS

In this chapter, I provide the analysis of the different norms of practice that were utilized by Caroline in the first two science units. Through this review of norms and practices, I identify the differences between science and other disciplinary units in the kindergarten classroom, and provide details about the tools and norms of participation within science. Establishing norms and expectations is important because it allows students to have a road map or model to follow when entering into the community of evidence-based explanation building science. This is an essential model for the students to have as their learning is situated within this community of practice. Students are learning from the discourse, artifacts, and participants in this specific environment, and having established norms and expectations provides the students with the repertoire in use, the nuances associated with the engagement of members in the community, and how actions of negotiation occur within the community (Wenger, 1998).

Routines and roles are established in the beginning weeks of school. For kindergarten students, whose first exposure to a structured school environment is often the kindergarten classroom, this may be their first encounter with norms and procedures within a classroom context. The students and the teachers, working in an educational environment, co-construct the participation norms and roles over time. Participants in a classroom begin to adopt particular patterns for doing things, times and actions related to cues from peers and teachers and the school itself, i.e., bell ringing, announcements being made, etc. When students see, hear, and experience a variety of cues from their teacher, and classmates, they begin to develop patterns for participating within this space and time and environment. Understanding the patterns for these
interactions helps researchers to establish the norms for participation in the classroom and can be utilized as a basis for understanding interactional sequences and patterns throughout participant interactions in this study (Greeno, Collins, & Resnick, 1996).

**Norms for Caroline’s kindergarten classroom**

Kindergarten teachers are purposeful about developing norms within their classrooms. When students walked into the classroom on their first day of school they were introduced to a new educational environment. Caroline introduced students to their cubby location, where to hang their jackets, how to sign up for lunch, and options for what to do while you were waiting for the morning announcements (ethnographic notes, 9/14/11). Students were told to go to the carpet and find their special spot, which was given to them by their teachers and changed periodically throughout the year based on the fluctuating behavior of the students, before the morning announcements were announced. Some days all students managed to make it to the carpet before the morning announcements and other days some students were eating breakfast at a table while morning announcements were being read. After the morning announcements were read, most days Caroline or Taylor would lead the class in a warm-up activity to begin the morning meeting. Examples of warm-up activities included having students tell about something that happened over the weekend, stretching, playing music and singing, signing letters from the ASL alphabet, and, particularly at the beginning of the year, shaking hands with a neighbor and repeating each other’s names out loud (ethnographic notes, 9/14/11).

Every morning, before the students were in the classroom, Caroline or Taylor wrote an agenda on the board for the students to look at as they came to the morning meeting. The core of their agenda almost always stayed the same. The only time it changed was when they were having a field trip, guest speaker, weather delay, or school-wide activity that would interfere with
the amount of classroom time they would have during the day. The core subjects that remained consistent throughout the year were math, Daily 5, special (gym, library, art, music), lunch, morning meeting, recess, and quiet time. The order of these activities changed depending on Caroline or Taylor’s schedule and the school-wide activities of the day or week. Science and social studies were not included in the schedule on a daily basis, but were scheduled two to three times a week depending on the allotment of time provided in the daily schedule (ethnographic notes, p.2011). Typically, science and social studies were called unit time by teachers in the building, but Caroline specified science or social studies when she wrote the daily agenda on the board. Actual science coverage by unit was shown in chapter 3.

As students finished their warm-up activity, Caroline or Taylor, at the beginning of the year, would read the daily agenda to the students. Details would be given about each subject area. For example, when Caroline introduced math she stated that during math time students would be able to visit four different stations to work with pattern blocks, play the game Button Match up, color shapes, and practice numbers (ethnographic notes, 9/15/11, video, 9/15/11). After Caroline finished going over the day with the students, they entered into their first subject.

**Norms for math and language arts**

Math and Daily 5 were subjects in this kindergarten classroom that had very specific norms for participation. In speaking with Caroline and observing a few early days of kindergarten, it was noticeable that math and Daily 5 had a pattern to their participation. Caroline used stations during math time at the beginning of the year. The stations varied from day to day in content, and each day students were told which station they would be starting at and where they would be going to from there. Some stations had individual activities for the students to complete, like the pattern block station where students would receive a shape and use the blocks to make
that same shape, and some of the stations were game related where peers would work together to complete the activity. After 25-30 minutes Caroline or Taylor would clap their hands rhythmically and students would repeat the clapping pattern to receive instructions on what to do next. Most days included directions on cleaning up the station and coming back to their special spot on the carpet. In speaking with Caroline about the daily schedule of kindergarten (ethnographic notes, 9/14/11), she mentioned that after math, unit, or Daily 5, she likes to give the students a small break in the form of snack time, getting a drink of water, performing yoga, or listening and dancing to music for 1-3 minutes to give the students a change of pace before entering into another subject area.

Daily 5 had a routine for participation in Caroline’s classroom as well. Daily 5 was a language arts program that this elementary school used every day. At times, Caroline spoke about it as Café and at times she spoke about it as Daily 5. Café is the overarching title given to the steps that are the focus for this language arts program. These steps include comprehension, accuracy, fluency, and expanding vocabulary (ethnographic notes, 9/14/11, & website the dailycafe.com). Each day students work on building their skills in the four areas mentioned above by participating in the Daily 5. Daily 5 activities included word work, where students would look around the room and copy words onto white boards for practice with writing, read to self, where students would pick a book of their choice and read it to themselves, work on writing, where students would write a story or letter in their writing journal, read to someone, where student pairs would pick two books of their choice and read out loud to each other, and listen to reading, where a student would listen to a story being read to them on the iPad or cassette player. Some days Caroline or Taylor would begin the Daily 5 time period by reading part of a book, calling this activity a Read Aloud. A Read Aloud did not happen every day and was usually connected to content from other disciplines. For example, one day Caroline read about an apple tree losing apples and the class was going on a field trip later in the week to a fruit farm to hear about
growing apples and fruit (ethnographic notes, 10/14/11). Caroline used this Read Aloud time to ask comprehension questions, have students listen to reading, and to provide students with ideas for writing in their journals.

At the beginning of Daily 5, Caroline would introduce the available options to the students and call out their names for them to choose where they would like to begin. Caroline usually had 4-5 students in each group for Daily 5 activities. As students’ names were announced she recorded where they were beginning and when they moved to the next station and the following station. Caroline usually implemented three rounds of Daily 5 per class period. At the beginning of the year the rounds lasted 3-5 minutes, depending on student behavior and reading stamina. As student’s reading stamina increased Caroline increased the time for each round to 10-12 minutes. Caroline or Taylor timed each round using a “kitchen timer” and when the bell rang, Caroline or Taylor made an announcement about the round being finished, asked students to put their materials away and come back to their special spots on the carpet. Students came back to the carpet and began the process of choosing an activity again. During the rounds Caroline would gather a group of students who were working on a similar skill in Café and have a small group discussion with them focused on that skill area. For example, students working on fluency brought a book from their book box to the carpet and would take turns reading to her and each other for the round (ethnographic notes, 9/14/11). Math and language arts instruction became routine in this classroom over time. Each began with group direction, independent or peer work time, direction about cleaning up, and coming back to the carpet.

**Norms for science**

Science instruction in this classroom did not follow a prescribed daily or weekly routine, and was grounded in a common, socially constructed practice, CER (see Chapter 2). Norms and
roles for participation were developed over time and routines and norms from math and language arts instruction were explicitly present throughout science instruction. For instance, students usually began unit instruction in science on the carpet in their special spot. Directions were given to the whole group while they were sitting on the carpet for a majority of the days at the beginning of the year and students were directed to work independently or in small groups. After their independent or small group time was completed, usually after 15-25 minutes, students were asked to come back to the carpet after cleaning up their materials. If time permitted Caroline to begin a discussion about what they had written, observed, or drew during their independent or small group time then she would lead a discussion. If time wasn’t available at the end of the independent or small group time Caroline would follow up by having science time the next day and revisit the previous day’s topic. This differed from math or Café time because when the time allotted for small group or individual work ended for these subjects, Caroline frequently transitioned into the next activity without a discussion of what each student had worked on during the allotted time.

Reviewing previous work as a starting point

This mode of science instruction was explicitly different than that of math and language arts in this classroom in a few ways. Caroline began science time by reviewing with students what they had previously discussed in science before directly asking them a question or providing them with a specific prompt before they were dismissed from the carpet to explore independently or in a small group. For example, students were asked to draw or write about the Gingerbread Bear hunt that took place throughout the school. Specifically, they were asked to show or write about a clue or piece of evidence that helped them locate the Gingerbread Bear (ethnographic
notes, 10/3/11). The next day, as students were sitting on their special spots on the carpet, Caroline began the lesson by stating (transcript, 10/3/11a):

19  Caroline    Mrs. McDyre
20  Caroline    loved hearing
21  Caroline    you talk about the Gingerbread bear
22  Caroline    and you were **retelling us about the things you found**
23  Caroline    during that Gingerbread bear adventure
24  Caroline    **everything you found**
25  Caroline    was a piece of evidence
26  Caroline    We found
27  Caroline    sprinkles
28  Caroline    That was a piece of evidence
29  Caroline    **that helped us know that the Gingerbread bear was still here**

As Caroline reminded the students about what they did the day before and about the adventure they had taken to find the Gingerbread Bear (transcript, 10/3/11a, lines 22-29), she prompted her students to add onto what they may have included in their science notebooks. Leading the discussion by means of **review** helped Caroline’s students connect to their previous knowledge from the days prior and add onto the present discussion. One student was able to add that, “we, um, smelled him” (transcript, 10/3/11a, 42-44), which enabled Caroline to extend the conversation about evidence and senses.

**Using questions to frame science time**

After the review period Caroline directed all students to a specific question, task, or prompt for the next period of time. By using the same prompt, question, or task for all students, science instruction became a time when students had a unifying explicit goal. Whether students were working independently, note booking, or in small groups, finding the temperature of water, they all had the same end goal and this end goal was repeated continuously throughout the directions. In the same lesson as the previous example, Caroline is asking students to think about
where to hide a magnifying glass in their classroom for the researcher to find. She would like for her students to think about the term evidence as they come up with hiding places and clues to for the researcher (ethnographic notes, 10/2/11).

In lines 66-71 Caroline introduces the lesson for the next few days by telling students, “Instead of making a Gingerbread Bear hunt for Mrs. M. to do, we are going to make the case of the missing magnifying glass” (transcript, 10/3/11a). She elaborated on the goal in lines 93-107 by asking the students to look at the magnifying glass and think about where they would like to hide it (transcript, 10/3/11a).
Three more times in the matter of a minute Caroline repeats her question, where would you hide the missing magnifying glass, before giving students their science notebooks. As she handed the science notebooks to each child she asked them to turn to the next empty page and again asked them, where would you hide the missing magnifying glass? (transcript, 10/3/11a).

**Using science talks as a way to share CER**

After independent work time or small group time Caroline always had a discussion with her students, which she called a science talk. After students were finished writing and drawing hiding places in their notebooks, Caroline had them come back to their special spots on the carpet and share with each other the work that they had done (transcript, 10/3/11a). In a little under four minutes, Caroline facilitated a discussion where students were sharing their ideas about where the magnifying glass should be hidden. Three students were able to share their ideas for the hiding spot of the missing magnifying glass while others commented on their drawings. Caroline used this same strategy after a lesson on changes in the environment. Students were asked to draw a tree from a picture that was in their notebooks form the beginning of the year and after they had made their drawings and wrote a few words to describe the tree, Caroline asked the students to sit on the carpet and tell the researcher about what they had written, drawn, or were wondering about the changes in the tree form the beginning of the year to the present day (transcript, 10/14/11a). Using a science talk after the independent time or small group time of a lesson helps to provide a time for processing for student ideas, a time for sharing the work that was accomplished by the students, and a time for wondering.
Using KLEW charts as a tool for CER science talks

Caroline used a distinctive tool in order to facilitate discussion among students and teachers about many lessons, the KLEW chart. This KLEW chart was developed as a tool for argument mapping and has been used to display student thinking as students co-construct their claims about science phenomenon (Hershberger, et al., 2006). Students state what they already “know” or “think they know” (K), what they have “learned” (L) from the investigation, or the claims they are trying out, what “evidence” (E) helped them to claim what they have learned, and what they still “wonder” (W) about the phenomenon or new questions that they would like to investigate (Hershberger, et al., 2006). This tool was not used in language arts or math time, and was specific to science instruction. The KLEW chart is a tool that helps to capture student’s thoughts and wonderings as a discussion is happening. Caroline introduced the KLEW chart to students after a few science lessons when she felt they were getting the hang of some of the terminology (ethnographic notes, 10/14/11). Caroline referenced the prior math class as she stated, “figuring out ways to show what you are thinking and to get it down on paper” (transcript, 10/17/11, 49-52), “well, in science we do a lot of that too. Not only in your notebooks do you have to show us what you are thinking, but we have to have a way to keep track of what you are learning and how we know you are learning it” (transcript, 10/17/11, 53-61). She reminded students of the question she had previously asked them, How is our clothing different today than it was on our first day of kindergarten?, and she asked students to think about the observations they made of the tree from their nature walk (transcript, 10/17/11) and the changes in the tree from the beginning of the year to now. As students began discussing the changes in the tree and their clothing, Caroline heard some wonderings from the students. She reiterated the reason for using the KLEW chart, Figure 4-1, and told the students, “…I plan to be talking about this some more later and I don’t want to forget what you said so, look up here because I might need your
help. This light bulb means this is what we are learning about these questions” (transcript, 10/17/11, 464-471).

As this discussion progressed Caroline introduced the different parts of the KLEW chart (the light bulb represented something they have learned, eyes represented something that have observed or the evidence, and the question mark represented wonderings that they have about the question or evidence from the investigation) when students talked about the specific areas and she continually reminded students that using the chart was a way for her to remember what they were saying and for them to remember what was being said (transcript, 10/17/11, 735-742). Including time for discussion is one of the norms of participation within Caroline’s science classroom.

Another mode of participation for students was the use of a science notebook.

**Using science notebooks as a tool for recording CER**

Caroline used science notebooks in her kindergarten science class. These notebooks were lined journals with hard covers and each had a student’s name on the front cover with a label displaying the terms “science notebook.” When Caroline wanted students to write or draw in their science notebook she had a routine way of giving students directions and guidelines for their
science note booking time. Caroline aligned science note booking with writer’s workshop, also known as, Daily 5 work on writing time, in a couple of different ways with a few exceptions. She introduced students to their science notebooks at the end of September before they had participated in a science investigation. Caroline wanted students to take what they had learned when they were looking for the Gingerbread bear, a social studies unit focused on the community within the school building, and record it in their science notebooks. Caroline connected the task to writer’s workshop, a more familiar routine for the students, when she said (transcript, 9/28/11):

Caroline: It’s kind of like writer’s workshop time, and since it is our science notebook we will be drawing right in our notebook as well. You need to find a spot where nobody’s sitting right next to you. You may spread out all over the classroom and I want you to get your marker box.

In this transcript, Caroline stated a few similarities to writer’s workshop and some distinguishable differences between what students write in their writing notebook opposed to their science notebook. Students were asked to find their own spot and to spread out, just like when they are working on Daily 5; however, Caroline designated that they were to bring their marker box with them because in their science notebook they will be drawing “right in it” (transcript, 9/28/11, line 74). The next time this class had science, Caroline wanted students to use their science notebooks to record their ideas for hiding a magnifying glass. After reviewing the work they had finished from the last science class, Caroline reviewed with the students their new directions and stated (transcript, 10/3/11a):

Caroline: This is like Daily 5 you choose a good spot where you’re not going to worry about anyone else’s decisions or what they are doing. This is your spot.
Again Caroline made a reference to finding a spot, just like Daily 5, and added that students were to use pictures and words while they completed the task.

Unlike writing journals where students were given time to write their own stories or compose letters to family and friends, each entry that Caroline asked students to write in their science notebook during the first two units of the year was given a specific purpose, task, or question to answer and each student was given the same prompt. For example, when Caroline asked students to think about where they would hide a magnifying glass she asked them repeatedly, *Where would you hide the missing magnifying glass?* (transcript, 10/3/11a, 107, 113-115, 139-140). When students found a spot and began to work that day, they drew pictures or wrote words describing where they would hide the missing magnifying glass (photos of NB, 10/3/11).

Another common use for the science notebook was a place where data could be recorded. When students worked on investigations and needed a place to record their observations or findings, Caroline encouraged them to write in their science notebooks. At times Caroline included a data sheet for students to fill out as they observed different phenomena. Here is an example of a student’s science notebook from a day when the student worked on determining the temperature of the water sample at each station, Figure 4-2. Caroline wanted students to gather evidence about how thermometers could be used as a scientific tool and had students record the temperature that they measured from a thermometer at each station (student notebook, 10/2/11).
The specific question that students answered when they participated in this investigation was, *How does a thermometer show us how hot or cold something is?* This student colored in the thermometers to correspond with what the thermometer at each station showed and then recorded the temperature for each sample of water.

Lastly, the science notebook was an integral piece in providing a scaffold for science talks because the notebooks contained the thoughts and data relevant for the science talk. Students were asked and encouraged to bring their notebooks to the carpet for science talk time. In this first example students were asked to record the observations they made from a nature walk into their science notebooks (photos, 10/14/11). Caroline wanted the students to share what they noticed from the nature walk with each other and began the science talk in this manner (transcript, 10/14/11a):

8  Caroline  What were you noticing about the changes of our tree?
9  Caroline  Who would like to start?
10 Caroline  When you have an idea
11 Caroline  that means it is your turn
12 Caroline  you’ll get to take your notebook out in front of you and you’ll get to tell us about what you put in your notebook

Caroline modeled a norm for participation in science talks when she showed students how to use their notebook during their time to talk. In this case the notebook was used as a
reminder for the students of what they had previously recorded and could be used if needed
during the science talk. Caroline also referred students back to their notebooks during a science
talk when the student couldn't remember exactly what they were trying to say or needed help
backing up their claim with evidence (transcript, 10/4/11a):

75  Caroline what did you notice__
76  Caroline do you want to bring out your notebook and tell us
77  Caroline what you saw
78  ____ see some green and yellow
79  ____ and this one I see some more yellow
80  Caroline good
81  Caroline so you are telling us what (_) saw
82  Caroline tell me what you are noticing?
83  Caroline what did YOU put in your notebook?
84  Caroline you did a very nice job
85  ____ um
86  ____ I don't know
87  Caroline Do you think that you saw some of the things (_) is talking about
88  Caroline Did you see more colorful leaves this time
89  Caroline than at the beginning of the year?
90  ____ (shakes head yes)
91  Caroline How did you know that?
92  Caroline Can you tell me where you were looking?
93  Caroline What made you decide that you noticed more colored
94  Caroline leaves this time?
95  Caroline Can you show me in your notebook
96  Caroline where you see that?
97  ____ (inaudible) I saw more leaves (pointing at picture in notebook)
98  Caroline ok

In this lengthy excerpt, Caroline continued to prompt the a student for evidence to
support his claim and she used the drawings he had made in his science notebook to help him find
the observation he had made that would lead to his answer. Caroline used science notebooks in a
variety of ways and provided alignment to writing workshop journals when she could.
Deliberate pedagogical choices

Caroline was deliberate about the choices she made in the kindergarten classroom about facilitating science talks. She used specific talk moves (Michaels, et al., 2008) when the science talk was not progressing. Talk moves are phrases or questions, listed in Table 4-1 below, that, when used at a certain time, may help to strengthen the time between student interactions.

Caroline used the talk move of revoicing the most during the introductory unit. Revoicing is the act of restating what the previous person has said in a different way, where you capture the meaning but may use different words or phrases hoping to incite more student responses (Michaels, et al., 2008). In this example of revoicing Caroline revoiced what a student had said and asked for the student to revoice his response as well (transcript, 10/17/11):

177 student she’s not wearing long sleeves
178 Caroline uh, huh
179 Caroline that’s a very interesting point
180 Caroline I want you to hear what (__) said
181 Caroline Can you say it one more time (__)?
182 (__) She’s not wearing long sleeves
183 Caroline Can you be more specific?
184 Caroline When was she not wearing long sleeves?
185 (__) On the first day of school

By having the student revoice what was said Caroline wanted his peers to hear that he made an observation and now the class discussion moved from simply stating observations to making comparisons about the attire students were wearing and the time of year that the pictures were taken. In this next example, Caroline used two talk moves concurrently to help facilitate the discussion about changes in the environment. Not only did she use revoicing, but she coupled revoicing with prompting for further participation to increase participation in the science talk (transcript, 10/14/11a):

58 student there was really a lot of green but now there is more yellow
59 Caroline (__) said
60 Caroline last time at the beginning of kindergarten
This excerpt begins with Caroline revoicing what a student just said and prompting the class to add on to what the student said, to say something different, or to state what they observed about the changing trees. Without using talk moves, Table 4-1, Caroline has said that the depth of the science talk and amount of direct participation has not been as productive as the times when she has concentrated on explicitly using talk moves (ethnographic notes, 9/14/11).

Table 4-1: Talk moves invoked in first two kindergarten units

<table>
<thead>
<tr>
<th>Talk Moves (Michaels, et al., 2008)</th>
<th>Introductory unit Incidences</th>
<th>Changes in Body and Environment unit Incidences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revoicing</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Asking students to restate someone else's reasoning</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asking students to apply their own reasoning</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Applying reasoning to someone else</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Prompting for further participation</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Asking to explicate reasoning</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Using wait time</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Using the phrase agree or disagree</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Putting a finger in the air for thinking about an answer</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

One of the more profound differences observed in Caroline’s kindergarten science classroom was the use of scientific terms and references to actions that scientists enact. Caroline used the terms listed in Table 4-2 below within the first two units of study to create a strong
connection to her students as budding scientists (ethnographic notes, 9/14/11). During the very first day of science instruction not only referred to the passing out of science notebooks as something scientists would use, but when she described what she wanted the students to put in their notebooks, she said, “You are going to get your very first science notebook because “scientists do a lot of thinking and drawing.” “…sharing your drawing, your writing, your writing about what kind of mysteries or problems, or questions you’re solving” (transcript, 9/28/11a, 11, 13; 9/28/11b, lines 1-5).

Caroline wanted students to come to the carpet for science talks prepared with questions, ideas, and/or wonderings. She also wanted her students to see her and her co-teacher as scientists as well. In this next example, Caroline told the students that her and Taylor have been listening to them talk about the changes in the school yard and that they want to investigate the students’ ideas in more depth (transcript, 10/14/11b):

44  Caroline  Taylor and I are wondering
45  Caroline  what you are thinking about all of these things you are sharing
46  Caroline  about our trees outside
47  Caroline  what you might see happening when you come to school in the morning?
48  Caroline  I know many of you are saying our tree is losing its leaves
49  Caroline  I’m wondering what you are thinking about that
50  Caroline  What are some things that we can learn
51  Caroline  together this year
52  Caroline  that you’d like to learn more about some of these things that are happening?
Table 4-2: References to what scientists do in first two kindergarten units

<table>
<thead>
<tr>
<th>References to what scientists do</th>
<th>Introductory unit incidences</th>
<th>Changes in Body and Environment unit incidences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Drawing</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Sharing</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Writing</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Problem solving</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Question solving</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Showing/Demonstrating</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Finding evidence</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Gaining knowledge from evidence</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Using tools</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Working</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Wondering/Questioning</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Listening</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Talking</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Using a science notebook</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Observing/Noticing</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

Caroline hoped that by making connections between her kindergarten students and actions of scientists that her students would begin to see themselves as scientists because they performed many of the same actions. Students brought their notebooks to the carpet and began to participate using the norms of the science classroom in the later unit of study (see chapter 5). Caroline was instrumental in helping to set the norms of participation in her classroom as she used similar techniques in both math and language arts as she did in science, but science instruction had a variety of subtleties. Caroline believed that these subtleties helped to create meaningful participation and conversation in her classroom among teachers and students (ethnographic notes, 10/14/11). Caroline’s use of these norms mediated a “science space” for students, a space where they could begin to practice being part of the community (Lave & Wenger, 1991). Caroline was situated as the expert in this space, the one with the knowledge about the content and practices, the one that students looked to for modeling of how to participate.
in this science space. The tools and discourse were also modeled by Caroline in this space as a way to demonstrate to students, the novices, how to use these in the kindergarten science class.
Chapter 5

CASE STUDIES

This chapter contains a summary of the Light and Shadows unit and how the students and teachers participated in the unit. After the description of the unit, each case study is presented, and within each case study the authoring and positioning of each girl is highlighted as it pertains to their identities-in-practice.

Light and Shadows Unit

Caroline began the Light and Shadows unit in mid-January, after students had come back from winter break. Students in this classroom had already been introduced to three units in science, and this was their second to last unit for the school year. Caroline had never taught the Light and Shadows unit before using the constructing claims from evidence model. This was new territory for her to cover by asking students questions and letting them explore and investigate to find answers. Caroline used the same practices with this unit as she had in the prior units; for instance, she broke this unit into different parts. First, the students investigated light and what makes light. After the students explored objects that created light, they were asked, when do we see shadows and when do we not see shadows? Students investigated making shadows with a projector, a flashlight, and a lamp in small groups. The following day, students brought their science notebooks to the carpet. After a lengthy, fifty-six minute discussion about when they saw or did not see shadows as they were using the objects from the previous day, students recorded their observations in their notebooks. Caroline wanted to challenge the students to think about the different sizes and shapes of the shadows, especially after she heard them talking about them
throughout the discussion from the previous day (ethnographic notes, 1/25/12). To that end, she and I decided to have the students trace the shadow from a trapezoid block, which was traced into the students’ notebooks in two different positions. After the students had some time to trace the shadows from the two different block positions, Caroline had another science talk with the students about what they noticed about their drawings and how they would describe what they saw. Within this discussion, Caroline and I heard the students using the words “reflection” and “shadow” synonymously. After that class, Caroline and I had a lengthy planning discussion about the next course of action (ethnographic notes, 1/30/12). We both wanted the students to have the opportunity to distinguish differences and similarities between reflections and shadows. The next day, students had the opportunity to investigate shadows and reflections as a whole group before they were asked to write about their thoughts regarding reflections and shadows in their notebooks. After six days of working on the Light and Shadows unit, Caroline wanted to assess where the students’ thinking was on the content, so I interviewed each student and asked them questions about light, shadows, and reflections (Appendix E). As I interviewed the students, I also videotaped them and compiled their clipped interviews into a short movie. Caroline introduced the movie to the students to incite a discussion among their science community about what they were thinking and wondering about shadows. Caroline would play the video and stop it to ask students if they heard what their peers were saying about and explaining about shadows and reflections and whether they agreed, or disagreed, or had something to add. After the discussion about the movie, Caroline wanted to have the students write about what they knew one more time. Before they did this, Caroline displayed the KLEW chart for the Light and Shadow unit. She had taken sentiments from the students, from class discussions, from their video, and from their notebook work to fill in the KLEW chart, Figure 5-1.
After students had a chance to write and/or draw in their notebooks about when they see shadows and when they do not see shadows, Caroline had a final discussion with them, and the dedicated time on Light and Shadows in class was completed.

Throughout this unit, I intensely documented the participation and artifacts of four girls, previously mentioned in the methods section of this paper. The following case studies highlight Molly, Olive, Josie, and Daphne as they experience the Light and Shadows unit. Further, they showcase how the students’ identities-in-practice are articulated, positioned, and supported by social practices within the science classroom by the teachers, themselves, and their peers. Each case study will begin with a description of the participant, a brief overview of their identities-in-practice, a section detailing the participant’s authoring of their identities-in-practice, and end with a section describing the positioning that may have affected their identities-in-practice. The sections on authoring and positioning are artificially divided in this study to show the boundaries.
between the two actions; however, it is difficult to note identities-in-practice without calling on the fluidity of each authoring and positioning.

In writing this case study I will show the reader how Molly, a kindergarten student in the middle of the year, became known to me as the teacher, helper, demonstrator, and persistent science learner within this classroom. I will show how she uses the social practices of science to help her peers and her teachers learn more about the unit, Light and Shadows. Molly does not do this on her own; she is positioned as a teacher, helper, demonstrator, and persistent science learner throughout the 11-day unit and authors herself in this way as she is trying on these identities-in-practice.

Molly’s Case: Consistent teacher, helper, demonstrator, and persistent knowledgeable science learner

Molly, a six year old, female student from a family of six, including three siblings and two parents is the second oldest child in her family. Her brother also attended the same school, is a year older than her, and has developmental delays. Often Molly could be seen helping her brother get to his classroom or waiting for him at the end of the day to be picked up by a parent. Molly was an eager participant in setting norms in the science classroom. She frequently had her hand up, and would sit and wait to be called upon. She seemed enthusiastic to learn about science and contributed greatly to class discussions. Molly’s parent commented on how excited she was to learn about sounds, and that at home she loved “testing sounds” (Molly parent questionnaire, 2012). Molly’s science notebook was a collection of drawings and words, colorful and vast. She frequently took all of the time allotted to work in her notebook and, at times, would work past the time allotted (ethnographic notes, 1/31/12). Throughout the Light and Shadows unit, Molly became a constant participant; either being called on by Caroline, being asked by her peers for
help or clarification, or by asking questions of herself, her classmates, and Caroline to further the
class discussion and wonderings. Within this one unit of the kindergarten curriculum, the
numerous interactions Molly had with her classmates and her teacher showcased the ways that
she was positioned in the class, the ways she authored herself, and the ways she used the social
practices of science. Each contributed to her developing school science teacher, helper, and
demonstrator identities-in-practice. This case study will explore the ways in which Molly
authored herself as a teacher, helper, demonstrator, and persistent science learner during science
instruction, and was positioned as a teacher, helper, demonstrator, and persistent science learner
by her teacher and peers.

**Authoring herself as a teacher, helper, demonstrator, and persistent science learner**

As the unit on Light and Shadows began, Caroline introduced the KLEW chart to the
students. As she began asking students questions about what the symbols on the KLEW chart
meant, Caroline asked the students directly what the eyes on the chart meant. Molly held up her
hand immediately, was called upon, and answered, “Give your attention to something” (video
transcript, 1/17/12_2, line 80 ). Not even one question later, Molly had her hand up again to
answer another question. This time Caroline was asking the students if they remembered what
they were supposed to be writing about in their journals and Molly stated that the question they
were supposed to be answering was, “Where does light come from?” Throughout these
exchanges, Molly was helping Caroline review the day’s objectives and was ready to participate
in the science work of the day. She even added her own helpful comment to the review of the
steps for the day’s work. Caroline continued to give students a step- by- step process to follow
after they’d been given their notebooks. Molly added to her directions without a skipped beat
(1/17/12_2, lines 144 & 152).
In this segment of talk, Molly was not asked to add on, but she did as soon as Caroline took a breath. Molly added to the directions by telling her peers that they may also “write some pictures.” Caroline had not mentioned drawing pictures before this time and after Molly inserted that idea to her classmates, Caroline repeated the option, but with different wording, “Draw pictures or write some words.” As evidence of Molly’s helpfulness to her classmates during this notebook work, many peers did indeed draw pictures of light, including pictures of the sun, light bulbs, and fire (student notebooks, 2012). In this scenario Molly was also acting as a teacher of sorts, adding onto the directions by telling her peers another helpful action that they may want to complete while they were working in their notebooks.

After students had time to work with various sources of light in small groups, they were asked to come back to the carpet with their science notebooks to investigate the different light sources as a class. Students were spread out in a large circle on the rug, facing Caroline, who sat at the front of the room with the different light sources. As Caroline showed the students each light source, they were asked to draw the shadow that they saw being made from the light source in their notebooks, remembering to draw the light as well as the shadow. As the students were working with the projector as the light source, one of Molly’s peers stated that she couldn’t draw what she was being asked to draw and Molly came to her rescue. Molly showed Josie that she
could do the drawing by showing her the drawing she made, and told her to “just color it in” (1/25/12_2, lines 425-429).

Figure 5-2: Molly’s notebook, p 20

After showing Josie what she did to display the shadow and the coloring in of the bunny, Josie began to work on her own drawing, closely resembling what Molly showed her. Molly was authoring a teacher identity-in-practice, a helper identity-in-practice, and a demonstrator identity-in-practice during this interaction with Josie as she helped Josie to understand the task by demonstrating to Josie how to draw the shadow, similar to how a teacher would show a student what to do next. Before Molly took the time to help Josie by showing her what she had done, Josie had not drawn anything in her notebook. She was listening to the discussion, but was not completing the task Caroline had asked the students to complete while they were on the carpet. With Molly’s help, Josie began to become engaged in the practices of the science discussion.
As the students completed their drawing tasks in the science notebooks, Caroline asked if they were wondering about all of the surfaces they were making shadows on. She gave them a few more minutes to finish what they were writing. As she did that, Molly began to add on to what she was working on by blurting out to the class that she was going to write why. The following dialogue ensued (1/25/12_3, lines 30-64):

30 Molly oh
31 Molly I’m going to write why
32 Caroline what?
33 Molly I am going to write why
34 Caroline why?
35 Caroline ok
36 Caroline why
37 Caroline what?
38 Caroline when you say why
39 Caroline what are you thinking?
40 Molly Why are the shadows on the wall
41 Caroline Why are the shadows on the wall?

During this sequence of interactions, Molly added on to what Caroline had asked the class to do by stating that she was going to write why, and after Caroline prompted her, she responded by saying she was going to write why shadows were appearing on the wall. This demonstrates Molly’s comfort level at authoring her teacher identity-in-practice. Just like a teacher would as her students to write a justification for their answer, Molly also wanted the class and Caroline to
know that she was going to write a justification for her answer. Caroline used this authoring space to question Molly about her learning as she asked her about what the phenomenon that they studied (lines 42-56).

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Caroline</td>
<td>Do you know what we had to do?</td>
</tr>
<tr>
<td>43</td>
<td>Molly</td>
<td>because there was light</td>
</tr>
<tr>
<td>44</td>
<td>Caroline</td>
<td>good</td>
</tr>
<tr>
<td>45</td>
<td>Caroline</td>
<td>there was something else that had to happen before we saw the shadow</td>
</tr>
<tr>
<td>46</td>
<td>Molly</td>
<td>we put our hand there (showing the space in front of the flashlight)</td>
</tr>
<tr>
<td>47</td>
<td>Caroline</td>
<td>and where was</td>
</tr>
<tr>
<td>48</td>
<td>Caroline</td>
<td>there was something important about where we put that hand or something</td>
</tr>
<tr>
<td>49</td>
<td>Molly</td>
<td>it on the wall or</td>
</tr>
<tr>
<td>50</td>
<td>Molly</td>
<td>on the floor</td>
</tr>
<tr>
<td>51</td>
<td>Caroline</td>
<td>ok</td>
</tr>
<tr>
<td>52</td>
<td>Caroline</td>
<td>think about the light</td>
</tr>
<tr>
<td>53</td>
<td>Caroline</td>
<td>where was it when you think about the light</td>
</tr>
<tr>
<td>54</td>
<td>Caroline</td>
<td>behind the light or</td>
</tr>
<tr>
<td>55</td>
<td>Molly</td>
<td>in front of the light</td>
</tr>
<tr>
<td>56</td>
<td>Molly</td>
<td>in front of here (pointing to the space in front of the light)</td>
</tr>
</tbody>
</table>

Again, in this interactive sequence, Caroline is asking Molly about how the shadows were created and Molly responded to Caroline by authoring another identity-in-practice. Molly chose to demonstrate her understanding of the phenomenon by “showing her the space in front of the flashlight” (line 46) and “pointing to the space in front of the light” (line 56). In both of these incidences, Molly demonstrated that she knew where the light source, object, and surface needed to be placed in order to see a shadow on the wall.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>Caroline</td>
<td>oh</td>
</tr>
<tr>
<td>58</td>
<td>Caroline</td>
<td>that was something Job said</td>
</tr>
<tr>
<td>59</td>
<td>Caroline</td>
<td>he said we had to make sure that something was in front of the light</td>
</tr>
<tr>
<td>60</td>
<td>Caroline</td>
<td>to see the shadow</td>
</tr>
<tr>
<td>61</td>
<td>Molly</td>
<td>when you put your hand on it</td>
</tr>
<tr>
<td>62</td>
<td>Molly</td>
<td>the light goes on your hand</td>
</tr>
<tr>
<td>63</td>
<td>Caroline</td>
<td>good</td>
</tr>
<tr>
<td>64</td>
<td>Caroline</td>
<td>thank you</td>
</tr>
</tbody>
</table>
In this last section of interaction that Molly has with Caroline, Caroline introduced another student’s ideas into the conversation with Molly and Molly responded by adding on to what the student had explained, authoring herself as a school science learner and helper to her peers and teacher.

Throughout this dialogue between Caroline and Molly, Molly begins to add her own thoughts to what Caroline has asked the students to do in their journals, and Molly’s additional thoughts encouraged Caroline to respond. Molly declared that she wanted to add reasoning to her notebook drawings, the why. Caroline used this opportunity to ask Molly what she was thinking about the different surfaces that the students saw the shadows on. Molly answered Caroline’s questions by adding on that she knew there needed to be an object (the hand), a surface (the floor or the wall), and light in order to see the shadow. This was the first time a student mentioned all of the conditions in which a shadow could be seen. Molly added to her thinking when she talked about where the placement of the hand had to be in order to see the shadow appear on a surface, “in front of the light, in front of here” (1/25/12_3, lines 56-57). Molly continued to talk about the placement of her hand and demonstrated for the class that when she put her hand on the light, the light went on her hand. This was a new way to talk about the path of the light in this class. Students had not talked about the light going onto their hands previous to this and when Molly talked about the light going directly onto her hand, Caroline thanked her and praised her. Molly was taking a chance within this talk and helping the conversation move forward with new ideas and by combining ideas from past discussions. She began the conversation by saying that she was going to add why to her notebook, referencing why she was seeing shadows, authoring her teacher identity-in-practice. She did not back down when Caroline asked Molly to explain herself, and as she was prompted by Caroline to elaborate on her thinking, she was able to do so by demonstrating her thinking and authoring another identity-in-practice. I see this persistence as Molly demonstrating an additional identity-in-practice as being a helper to the classroom school.
science community. Molly was trying something additional, something new, something the teacher did not even ask for her to do. Because of Molly’s interjection, her peers and teacher were able to hear her thoughts and be exposed to new ideas, which ended up carrying their way into future discussions.

The next day during science Caroline gave the students a trapezoidal block to use with their notebook and asked them to draw a shadow of the block. After students had time to work in their notebooks, they were asked to come back to the carpet to present their findings and discuss what they saw as they worked with the block. After a lengthy discussion about different shadows being seen throughout the class, Caroline began to change the trajectory of the discussion. She began to ask the students about the shadows they saw yesterday. Immediately after Caroline asked the class how shadows appear, like they did yesterday, Molly raised her hand and was called upon. Specifically, Caroline asked, “Did it just decide, ‘I want to be a shadow today,’ is that what happens” (1/26/12_8, lines 345-346)? Molly responded and the following dialogue was transcribed to show Molly’s response:

<table>
<thead>
<tr>
<th>Line</th>
<th>Speaker</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>347</td>
<td>Molly</td>
<td>it happens</td>
</tr>
<tr>
<td>348</td>
<td>Caroline</td>
<td>What happens, Molly?</td>
</tr>
<tr>
<td>349</td>
<td>Molly</td>
<td>the sun shines down on your body</td>
</tr>
<tr>
<td>350</td>
<td>Molly</td>
<td>and on the ground it designs into your body</td>
</tr>
<tr>
<td>351</td>
<td>Molly</td>
<td>but it’s black</td>
</tr>
<tr>
<td>352</td>
<td>Caroline</td>
<td>Why do you see a black part?</td>
</tr>
<tr>
<td>353</td>
<td>Caroline</td>
<td>What are you?</td>
</tr>
<tr>
<td>354</td>
<td>Molly</td>
<td>because</td>
</tr>
<tr>
<td>355</td>
<td>Molly</td>
<td>the light</td>
</tr>
<tr>
<td>356</td>
<td>Molly</td>
<td>isn’t the colors of your body</td>
</tr>
<tr>
<td>357</td>
<td>Caroline</td>
<td>so when you say the black part what part are you talking about?</td>
</tr>
<tr>
<td>358</td>
<td>Molly</td>
<td>it means your shadow</td>
</tr>
<tr>
<td>359</td>
<td>Caroline</td>
<td>the shadow</td>
</tr>
</tbody>
</table>

In this segment (lines 347-359), Molly is answering Caroline’s question about why they saw shadows yesterday by bringing in her experiences from outside. Within this dialogue, Molly expanded upon what she said the day before. In the previous class, Molly said that the light was on her hand. In this sequence of discourse Molly said that the sun shines down on your body,
continuing her thought from the previous day. On this day, however, Molly went further with her explanation. Molly added that the sun shines down on your body AND on the ground and you see a black part. Caroline asked Molly why you see a black part and Molly responded by stating that the black part was there because the light isn't colors from your body. Caroline had some trouble understanding Molly’s response and she continued to ask clarifying questions of Molly. Molly eventually explained that the black part she was referring to was the shadow. During this interaction Molly authored her identity-in-practice as a science learner, providing more explanations and reasoning to answer Caroline’s questions. Caroline continued to ask clarifying questions and Molly continued to answer by providing more reasoning and explanation.

Molly explained again, using different words, what she meant by the sun shining down on your body. In this explanation, Molly mentioned that the light divides onto your body, instead of designs onto your body. She tried to describe what she saw the sun doing as it shone down. She described the sun as continuing to divide down after it divides onto your body and then there is a black spot. Molly did not explicitly say that the sun divides around your body but does not shine in the area of the shadow, nor did she say, at this point, that the absence of the sun or light creates the shadow that we see. Throughout the dialogue of Molly’s sense making she is authoring herself as a persistent science learner, as a student that understands that answering a question may take a few tries to explain your reasoning. Caroline continued to ask her for clarification and even
asked her if she would like to try to tell her in a different way or have someone else help her.

Molly stuck to her explanation and told Caroline that she would like to explain in a different way.

Caroline asked her if she would like to try to tell her in a different way or have someone else help her.

Molly stuck to her explanation and told Caroline that she would like to explain in a different way.

Caroline prompted the next round of discourse, and during this round Molly added to her explanation that the sun moves and goes onto the ground and then makes a black thing. Again, Caroline probed Molly for additional explanations. Caroline tried to prompt Molly to say that the black spot was a shadow because her body was blocking the light, but Molly did not explain her thoughts in that manner. Caroline could not tell if Molly was telling her what she wanted to hear or not, so the prompting continued.
In lines 391-395, Molly began to demonstrate to Caroline and the class what she was saying to them. She stood up and said there is something black behind me. Caroline continued to ask her where that black thing was coming from and as Molly began to respond it was coming from light a fellow classmate interjected that he saw a shadow too.

Amazingly, Molly did not tire of trying to answer Caroline’s questions and probes. By continuing to respond to Caroline throughout this two-minute interval, Molly demonstrated that she was a willing and persistent participant in the science talk. She did not hesitate to continue with her line of thinking, even when questioned by Caroline on various occasions. Molly continued to help the conversation flourish, increasing the depth of the science talk and allowing others to participate. Eventually, classmates began to add their own thoughts to the discussion. Molly’s willingness to explain her thinking and reasoning demonstrated on a few occasions how comfortable she was with authoring her thoughts in response to her peers and teachers, even as she was questioned about her word choice and her ideas. Molly felt that she could add to the investigations, notebook pages, and science talks; and in doing so helped many of her classmates.

During Molly’s formal interview with me (Appendix F) at the end of the school year she continued to author her identities-in-practice as a science learner, teacher, and helper. When asked about who does science and how do people do science Molly told me scientists are anyone, mom, dad, teacher, kid. She added, “I do science by investigating, journaling,” and then opened her science notebook to show me what she had worked on. Molly said she liked being called on
in science, especially when Taylor picked her to answer a question in the Sound unit because she felt proud that she was picked (interview, 6/1/12, lines 117-134). She continued to tell me about how helping others in class by showing them her pictures or answering questions during science talk time on the carpet makes her feel happy (interview, 5/30/12). Likewise, her mom, who answered the parent questionnaire, responded by writing that Molly enjoyed to investigate science phenomenon at home and writes in her journal frequently (Molly parent questionnaire, 2012), authoring a science learner identity-in-practice outside of school.

**Positioning of Molly as science demonstrator, helper, and knowledgeable science student**

Throughout the Light and Shadows unit Caroline and Molly’s peers consistently positioned Molly as a demonstrator, helper, and knowledgeable science student. As the students worked on the carpet and drew what they saw, Caroline asked them questions about their small group work from the previous day. Specifically she asked the students if they were able to make shadows with the projector (1/25/12_3, lines 126-127). Molly responded by shaking her head up and down and then she said, “Yes” when called upon. Caroline invited Molly up to the front to demonstrate what she wanted to say and show. Caroline asked if there was something she was going to say that they needed to do first in order to see a shadow using the projector. Molly told Caroline and the class they needed to turn on the projector and plug it in to see a shadow (line 132). Caroline used the same pattern of questioning she frequently used with Molly throughout the Light and Shadows unit and asked Molly why they needed to turn on the projector and plug it in. Molly responded by saying that there is no light coming from the projector right now. Caroline repeated to the class what Molly had said and asked her class if that was an important part of the original question; How are shadows made? (lines, 138-139) Another student answered Caroline with a yes and the conversation continued. In this segment of discourse, Caroline was positioning
Molly as someone who could demonstrate how to recreate the shadows the projector group worked on yesterday and someone who understood the phenomenon. Caroline knew Molly had the answer to the question and chose to have her demonstrate what was needed in order to see a shadow from the projector. Caroline further positioned Molly as a student who helped to move the science talk forward by commenting on Molly’s knowledgeable answers when she asked students if what Molly said was an important part of the question. The positioning that took place in this scenario was more implicit because Caroline did not specifically call on Molly to help anyone, but used her knowledge and willingness to demonstrate a task to help move along the class’s thinking.

In this next example, Caroline was more explicit about positioning Molly as a helper and science learner within the science classroom. The class was involved in a discussion about the trapezoidal block and many students had heard many different explanations for the blocks’ shadows. In this section of discourse Molly was asked to help a peer by explaining her evidence for the explanation of why moving the block created a different shadow (1/26/12_8, lines 116-127).

116 Caroline Molly, can you help him out because you noticed the same thing?
117 Molly when you stood it up it had shadows all around it
118 Molly and I found a triangle shadow right there
119 Molly cause a shadow was a different shape
120 Molly because it was
121 Molly turned up
122 Caroline so Molly’s saying when she laid her block a different a direction on the paper
123 Caroline and she had it sticking up
124 Caroline which is what you did Hayden
125 Caroline she noticed that the shadow looked a little bit different
126 Caroline is that what you saw too Hayden?
127 Hayden yea

Caroline used Molly as an example to help a peer with his thinking. She asked her to restate, in her own words, what she saw happen with the different shadows from the block and by
doing so her peer was able to agree that he too saw a similar shadow pattern. Caroline rephrased Molly’s words and asked her to help her peer, and in doing so added validity to what Molly saw and stated and added to her science learner identity-in-practice. This same pattern happened again as the class discussed the differences between reflections and shadows.

A student was asked to stand in front of a mirror and Molly was asked to describe the student’s reflection. Molly made some statements about the student’s reflection and Caroline acknowledged her statements by saying ok and then rephrasing what she heard Molly say (1/31/12_1, lines 167-169). Caroline opened up the floor for Molly to describe her classmate. She chose Molly to help the class and by choosing to repeat what Molly stated, displayed a positive connection to Molly’s words in relation to the task, describing a reflection highlighting Molly’s identity-in-practice as a science leaner and teacher. Caroline emphasized Molly’s actions as being appropriate when learning and talking about reflections and Molly was able to explain what was happening in the classroom just like teachers do when they stand up in front of the class and explain what they are seeing to their students.

Caroline even used a taped version of Molly talking to help other students think about light and shadows. The clip of Molly that was shown to the class from our interview together was a segment that showed her explanation to me about how light is important for making shadows. She continued her interview by telling me that she traced her shadow in the past and that it had looked like her, pigtails and all (2/9/12). Caroline wanted to capitalize on what Molly had said in the video, so she stopped the video and repeated what Molly had said about tracing her shadow (2/21/12_3, lines 252-255). Caroline said, “She was making a shadow and the shadow looked like her” (255). She purposefully repeated what she wanted the students to pay attention to, but instead a student picked up on another statement that Molly made. Previously in the video Molly had said that temperature was involved in making a shadow and Sam, a fellow classmate, decided to repeat that portion of Molly’s video clip. Caroline went along with this new line of questioning
and asked if the students thought the temperature had anything to do with making a shadow (2/21/12_3, line 262). She used Molly’s statements to open up the floor for questioning and wonderings from the rest of Molly’s peers. Molly’s thoughts were being used as talking points for her classmates and again Molly was positioned as the helper and science learner.

The final example of how Molly was positioned as a helper and science learner happened on the last day of the Light and Shadows unit. Caroline was reviewing the KLEW chart and wrapping up questions students had about the concepts. She called on Molly to clarify some final points. Caroline specifically asked Molly, *When do we not see a shadow? Can you tell me more about that Molly?* (2/22/12, lines 401-402) Molly responded by stating when there is not light you do not see a shadow. As evidenced before, Molly was called on again for clarification and in order to move the conversation forward. Caroline frequently called on Molly to give her thoughts and ask questions because by doing so Molly helped her classmates through sharing her explanations. Caroline wanted students to realize that they couldn't see shadows without light, objects, and surfaces. Molly already gave one answer that implicated the need for light in order to see shadows, but Caroline did not stop there. She restated what Molly said and asked her to continue with her reasoning (2/22/12, lines 426-440):

<table>
<thead>
<tr>
<th>Line</th>
<th>Speaker</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>426</td>
<td>Caroline</td>
<td>but Molly</td>
</tr>
<tr>
<td>427</td>
<td>Caroline</td>
<td>also said</td>
</tr>
<tr>
<td>428</td>
<td>Caroline</td>
<td>and if you didn't have this</td>
</tr>
<tr>
<td>429</td>
<td>Caroline</td>
<td>what’s this?</td>
</tr>
<tr>
<td>430</td>
<td>Caroline</td>
<td>what are you saying about this?</td>
</tr>
<tr>
<td>431</td>
<td>Molly</td>
<td>this is like</td>
</tr>
<tr>
<td>432</td>
<td>Molly</td>
<td>like a</td>
</tr>
<tr>
<td>433</td>
<td>Molly</td>
<td>projector</td>
</tr>
<tr>
<td>434</td>
<td>Caroline</td>
<td>this is the screen</td>
</tr>
<tr>
<td>435</td>
<td>Molly</td>
<td>the screen</td>
</tr>
<tr>
<td>436</td>
<td>Molly</td>
<td>and if you didn't have it</td>
</tr>
<tr>
<td>437</td>
<td>Molly</td>
<td>if it wasn’t here</td>
</tr>
<tr>
<td>438</td>
<td>Molly</td>
<td>and it went up</td>
</tr>
<tr>
<td>439</td>
<td>Molly</td>
<td>then you wouldn’t</td>
</tr>
<tr>
<td>440</td>
<td>Molly</td>
<td>see your shadow</td>
</tr>
</tbody>
</table>
Caroline tried to use Molly’s explanations to show that without a surface a shadow will not be able to be seen. Again, Molly explicated her reasoning for why a shadow would not be seen by adding that a surface is needed to see a shadow, essentially adding to what Caroline wanted for the final light and shadow discussion.

Throughout the unit Molly was continually asked to help other students by the restating her of explanations for light and shadow phenomena, which in turn gave her peers additional fodder for their own explanations and wonderings. Molly offered her help to others, demonstrated her understandings, and shared her science knowledge participating in this school science community. Much of her identities-in-practice were informed by using the social practices of science previously developed in the participation norms within the science classroom.

**Josie’s case: Doubtful and capable demonstrator**

Throughout this case study I will demonstrate how I felt Josie held two identities –in-practice throughout the science unit on Light and Shadows. Josie’s first vocalized attempt at science practices, whether it was writing or drawing something in her science notebook or trying to participate in a whole class discussion about the science question, would often take the form of “I don't know,” or “I don’t know how to…” As I interacted with Josie, I began to feel she was taking on the doubtful/helpless identity. But as I continued to pay attention to her views for participation in the science classroom community, I noticed that when she was comfortable with the content, she chose to participate by demonstrating the phenomena. It is for this reason that I coined Josie as the doubtful/dubious demonstrator. This case study will provide evidence of Josie’s authoring as a doubtful demonstrator and being positioned as such throughout the unit.
At the time of this study, Josie was a five-year-old kindergarten student. She lived at home with her parents, an older brother, and two dogs. Josie’s mother reported that Josie frequently liked to take care of the dogs, help her with the children she was watching, and practice doing homework like her older brother (Josie parent questionnaire 2012). She came to class on most days smiling and begging to tell a teacher a story from her adventures from the previous day (ethnographic notes, 9/29/11). Josie’s mother also reported that Josie was excited to talk about her science journal and told her parents how she would record observations and explain to them if things around the house were living or not living (Josie parent questionnaire 2012). Josie frequently picked to sit near her friend on the carpet, if given the choice, and was usually moved to another placement on the carpet (ethnographic notes, 1/25/12; 2/27/12; 4/13/12; 5/9/12). I noticed in a few video recordings that Josie would raise her hand after her friend had her hand in the air. I asked Josie why she liked to sit near her friend, Olive. Josie responded that she liked to see if her hand was raised and if she (Josie) had the same answer as her friend (video, 6/1/12_Josie). Josie checked for reassurance before raising her own hand on occasion, which resonates with her doubtful identity-in-practice, as does the amount of times Josie actually participated verbally in this unit. Josie raised her hand infrequently during the unit (ethnographic notes, 1/31/12) and had a small number of interactions with Caroline and the class in comparison to the other case study girls (14 interactions, see Figure 3-12). When Josie did have an interaction with Caroline, Taylor, or myself, she was doubtful at first, questioning her abilities and her understanding of the directions, but when Josie wanted to share about her knowledge or learning she chose to demonstrate this by using whatever manipulatives were nearby. Once, during a free writing time in class, Josie chose to write a science story. This story supports Josie’s identity-in-practice of the demonstrator. When she feels comfortable with the content, in this case her own science story, Josie chose to display, with the materials she had been given, Figure 5-4. Her story
is titled, The Science Kids, and it displays kids saying, “What can you do?” “I can do lots of things.”

Figure 5-4: Josie’s choice piece of writing about “Science Kids”

Josie’s two identities-in-practice garnered Josie attention from her teachers and peers as she proceeded throughout the Light and Shadows unit.

**Authoring as a doubtful demonstrator**

Josie’s first verbal authoring as a doubtful science learner happened on the third day of the eleven day unit. Josie had not participated in any of the whole group discussions until the time when all students were seated around the carpet with their science notebooks. Caroline demonstrated how the projector made a shadow and gave directions to the students about what she would like them to do. I noticed that Josie did not write or draw anything in her notebook, but instead, watched what others were doing (ethnographic notes, 1/25/12). When Caroline told the students, “I want you to take a couple of minutes and put it in your notebook,” (transcript, 1/25/12_2, lines 229-230) Josie responded by calling out, “I don’t know how to spell shadow”
Caroline responded by telling her to try her best and to draw a picture if that was easier. In this situation, Josie blurted out her doubtfulness and did not begin the task because of her inability to spell shadow. When I reviewed Josie’s science notebook after this lengthy science talk took place, I noticed that Josie had failed to add much content to her notebook pages. Not only did Josie verbally declare her doubt, but her doubt manifested in her almost empty notebook pages as well.

Figure 5-5: Josie’s notebook pages during the science talk

On the first page with the projector image, Josie did wrote “the switch we tried,” in response to Caroline asking the students what they needed to do to the projector in order to see a shadow. Josie wrote that they “tried the switch” (notebook, p.20). Later, within the same science talk, Josie also blurted out, “I can't draw it” (transcript, 1/25/12_2, line 425) when referencing the direction Caroline gave to the class to draw the shadow they saw from the projector. At this point, another student, Molly, helped Josie by showing her what she had drawn and told her to color it in. Josie responded to Molly’s help and drew a rabbit colored in with pencil at the bottom of her projector page. In both of these examples, Josie showcased her doubtful identity-in-practice. Each time Josie called out with self-doubt, a teacher or peer responded to her plea and Josie went about remedying her actions. Josie’s additional identity of demonstrator was also displayed.
during this same science talk. Directly after Josie told Caroline that she didn't know how to spell shadow, she raised her hand and said (transcript, 1/25/12_2, lines 235-244):

235 Josie Miss Caroline
236 Caroline Yes, Josie
237 Josie one of the times when I was with Miss Linda and she told me to put my
238 Josie hands like this (raised her hand above the carpet) and I saw my shadow
239 Caroline very good, Josie
240 Caroline ok
241 Caroline so keep that in mind
242 Caroline and look at that page with the projector
243 Caroline What is it that you are noticing that I’m doing
244 Caroline to make a shadow?

In this vignette, Josie demonstrated her knowledge for Caroline. She raised her hand and showed Caroline the shadow of her hand that appeared on the carpet. In this case, Josie chose to show Caroline she knew how to make a shadow with her hand, even if she didn't know how to spell shadow. Josie demonstrated she knew the big idea the class was talking about. As Caroline continued the science talk, she moved on to a demonstration of shadows being made by a flashlight.

The previous picture of Josie’s science notebook indicates that Josie did not participate in writing or drawing in the other two scenarios during the science talk. Caroline showed the class a shadow made by a lamp and a shadow made by a flashlight. During the science talk, students explained what they saw on the previous day from looking at the lamp and the flashlight and then recorded what they saw in words or in pictures in their notebook. Josie did not record anything in her notebook; however, she did want to add onto the discussion that her peers and Caroline were having about flashlights and shadows.

Josie raised her hand after a peer discussed the idea of light going on to their hand and the placement of the light in order to see a shadow. Caroline called on her and Josie said, ”I know
something else” (1/25/12_3, line 66). Instead of just saying what she knew, Josie chose to demonstrate what she knew while she explained herself (transcript, 1/25/12_3, lines 69-75).

69    Josie    when you turn the flashlight on  
70    Josie    and you put this under it (holding a pencil in her hand)  
71    Josie    it doesn't show a shadow  
72    Josie    but when you do it like that (pulls pencil up off of the floor)  
73    Josie    it does  
74    Caroline    oh  
75    Caroline    ok

Josie demonstrated where the object (pencil) needed to be in order to see a shadow, and added on to what her peers were saying previously. All of the previous examples were times Josie authored her doubtful and demonstrating identities-in-practice without being directly called upon in response to a question. Each of the previous incidents, Josie actively engaged herself in. The next series of examples are different in that they occurred in direct response to someone else.

Caroline asked the class if they were noticing anything as she was standing in front of them with the light (projector) turned off. She called on Josie immediately after she asked the question and Josie responded that she saw a shadow (transcript, 1/31/12_1, line 305). She continued to explain that she saw the shadow on the wall because the sun was shining (transcript, 1/31/12_1, lines 309; 312). In this excerpt, Josie used the evidence in front of her to explain why she was able to see a shadow even when the light from the projector directly in front of the object was not turned on. Josie continued to remain engaged in this science talk as the talk shifted about the shadow’s placement. When her friend Olive needed help, Josie asked Olive to pick on her so she could tell Caroline what to do to make the shadow appear on the screen: (transcript 1/31/12_2, lines 59-83)

59    Josie    Olive  
60    Josie    Olive  
61    Olive    Josie  
62    Caroline    Josie  
63    Caroline    What do you know?  
64    Caroline    What’s the problem?
Caroline: Can you tell us from your seat?
Josie: make um
Josie: you have to shine it back a little bit
Caroline: Why do I have to shine it back a little bit?
Josie: because
Josie: or
Josie: because the light is by that
Caroline: ok
Josie: she can’t really see her shadow very well
Caroline: be
Josie: in front of it
Caroline: in front of the…
Josie: light
Caroline: ok
Caroline: so she said move it back (Olive moves back)
class: oh
class: ahh
Caroline: Olive look what happened (her shadow on the screen appeared)
Josie: yea

This was a natural fit for Josie’s demonstrator identity-in-practice as Josie verbally told Caroline how to manipulate the light in order for Olive to see her shadow. Josie wasn’t directly involved in the demonstration, but her words and directions were responsible for the appearance of Olive’s shadow on the screen. Step by step, with prompting from Caroline, Josie helped her peers think about the placement of the light, object, and surface in relationship to a visible shadow.

To end Josie’s case with the authoring of the last excerpt would be a nice way to demonstrate she gained confidence from her demonstrations in class and moved from a doubtful demonstrator to a demonstrator, but this is not the case. Josie’s identities-in-practice will remain as the doubtful demonstrator because close to the end of the unit on Light and Shadows, Josie’s doubtful identity reared again.

In this vignette the class was asked to record in their science notebook their thoughts and pictures about the two words, reflection and shadow. After the directions were given, students began to work individually throughout the room. Josie called out, “I don’t know what to write about” (transcript 2/1/12_3, line 20). Taylor responded to her and restated the directions by
simplifying the task. Josie responded directly to Taylor by saying, “I don’t know what to do” (transcript 2/1/12_3 line 23). Taylor asked her to take it all in and think about it for a minute, and then Caroline told her that she could start with a picture. Josie produced the following work from that class period:

![Image of Josie’s reflection and shadow T-chart]

Figure 5-6: Josie’s reflection and shadow T-chart

She wrote “reflections are from many diff” and then stopped that section. She continued with “shadows come from many different thing.” After she demonstrated her need for assistance by calling out to the teachers, Josie was able to write her beginning thoughts into her notebook. Josie did not participate in the science talk the class had about reflections and shadows, so I am not able to compare her notebook ideas to any other ideas that she had during that time.

When Josie was asked about her willingness to answer questions in class she responded by telling me that she always raised her hand, and then paused and said that she did not (raise her hand) (Josie interview, 5/30/12). During this same interview Josie told me that she liked to look around to see who else had their hand up, and if her friend Olive had her hand up, Josie would raise her hand too. Josie’s utterances during the interview point to her doubtful identity-in-practice. She relied on her peers for help and guidance throughout the unit, from notebook help to
seeing if she should raise her hand. She told me that writing in her notebook was her favorite way
to participate in science because it was fun and that as soon as she heard the directions of what to
begin working on she would get right to work. Josie’s responses contradicted what was observed
in the classroom and her work in her science notebook.

**Positioning Josie as a capable demonstrator**

As stated previously, Josie did not accumulate many interactions within the Light and
Shadows unit. Many of the interactions occurred when Josie blurted out without being called
upon, but the interactions with Caroline that followed helped to support Josie’s questions and
uncertainties. For instance, when Josie said she didn't know how to spell shadow (transcript
1/25/12_2, line 231), Caroline responded by telling Josie to “try her best” and gave her another
option to replace writing, “draw a picture if that is easier” (transcript, 1/25/12_2, lines 232-233).
Caroline could have ignored Josie’s interruption and continued to direct the whole class with their
notebook instructions, but she chose to encourage Josie to do her best and gave her a different
option. The next time Josie spoke out in class was to say she couldn't draw, and this time, instead
of Caroline talking to her, a peer showed her an example of what to draw and Josie copied her
drawing of a shaded rabbit (see Figure 5-2 and Figure 5-3). With each interruption, Josie learned
someone would stop what they were doing and help her. In Josie’s last interruption during the
Light and Shadows unit, she stated that she didn't know what to do after Caroline directed the
class on what to do in their notebooks. Taylor took the time to directly engage Josie and Caroline
also gave Josie specific directions on what to attend to when she said, “start with a picture”
(transcript 2/1/12_3, line 26). Josie ignored Caroline’s option, as evidenced by Figure 5-6, and
chose to write what she knew about reflections and shadows, but she did complete the task. Each
time Josie was doubtful and questioned her abilities and understandings someone jumped in to help her by showing an example, or providing another option for the task.

Caroline did not purposefully use Josie as a demonstrator for phenomena (she never called her to show her learning), but she did encourage her demonstrations and praised her efforts. For instance, when Josie demonstrated that lifting a pencil up from the floor would display a shadow, Caroline praised her by saying, “**good**, ok, please **don’t forget what you’re thinking** because we are going to continue to talk about this. I think you’ve had some **really great ideas**” (transcript 1/25/12_3, lines 76-80). Similarly when Josie verbally demonstrated how to display Olive’s shadow on the screen, Caroline prompted her along the way and acknowledged her statements as correct answers (transcript 1/31/12_2, lines 68-84). Caroline ended Josie’s verbal demonstration when she asked if someone else could tell the class what they just witnessed. Having another student restate what Josie already stated was a subtle way of using the information Josie supplied to help enforce student learning and reinforce Josie’s role as a demonstrator.

Throughout the Light and Shadows unit Josie’s vies for attention, albeit minimal in comparison to others, displayed her doubtful identity-in-practice alongside her demonstrator identity-in-practice in a variety of ways. Caroline added to the complexity of Josie’s identities-in-practice as she positioned Josie as a capable science learner. Josie did not author this identity-in-practice during science instruction in the classroom by any means other than demonstrating her understandings, but she did author herself as a capable school science student when she was answering questions that I asked her in our end of the year interview.
Olive’s case: Hesitant questioner and knowledgeable science learner

Throughout this case study, I aim to provide the reader with evidence that supports my claim that Olive exhibits a hesitant questioner identity-in-practice. I seek to show how Olive’s desire to understand the scientific principles within the Light and Shadows unit helped to broaden the class’s science talk focus. That, coupled with persistent positioning from Caroline as a knowledgeable science learner, allowed Olive to practice her questioning and knowledgeable science learner identities-in-practice.

Olive was a six-year old kindergartener at the time of this study with an older sister and two parents at home. Olive’s mom reported that Olive spent a lot of her time outside of school playing with her sister, playing with her dog, and participating in science activities. Specifically, Olive spent a lot of time at a nearby marsh learning about wetlands and watching nature shows on television. It was also reported that Olive shared what she was learning in the science classroom at home with her family, specifically information about living and nonliving things, thermometers, seeds and shadows.

When Olive was asked about science class at the end of the year she had some very poignant sentiments. She remarked that in science class she thought about a lot of things and liked all of the classes (video, 6/1/12_Olive). She saw science as something “fun” where (people) “do stuff, talk about stuff, and test stuff” (video, 6/1/12_Olive). She also stated that everyone does science, except her dog. However, when I asked her about what people do when they are doing science, her initial response was, “I don’t know” (video, 6/1/12_Olive). I found this statement uncharacteristic of the previous answers she had given me, but as I analyzed her
interactions in the Light and Shadows unit, her response fit in with her identity-in-practice as a hesitant questioner and knowledgeable science learner.

Olive was not an overt participator in science talks. She seldom raised her hand (ethnographic notes, 9/29/11; 10/24/11; 11/16/11; 12/5/11) and could be found frequently attending to her friend, Josie, while on the carpet. Occasionally, Caroline and I would talk at recess about Olive’s peripheral participation and hesitant nature when asked a question during whole group science talks (ethnographic notes, 11/16/11). Caroline tried to limit Olive’s and Josie’s proximity to each other in an attempt to provide them with their own space to think on the carpet (transcript 1/31/12_1).

One space in the classroom where Olive challenged the identities-in-practice of hesitant questioner and authored the identity-in-practice of a knowledgeable science learner was within her science notebook. Olive’s writing in her science notebook was complete and it contained all writing, no drawings. She followed all of Caroline’s directions and wrote complete thoughts throughout her notebook pages. For example, here are pictures of some of Olive’s notebook entries from the Light and Shadows unit, Figure 5-7.

![Figure 5-7: Olive’s notebook entries for initial Light and Shadows questions](image)

Caroline asked the students to respond to the three questions, how are shadows made, when do we see shadows, and when do we not see shadows at the very beginning of the unit. Olive’s responses are succinct and complete for each question. She wrote (shadows are made) “by the sun
and you,” (we see shadows) “when the sun is shining,” and (we do not see shadows) “when the sun is not shining” (notebook, p 18). Olive’s notebook pages did not contain any additional questions or wonderings she had about the unit, which conflicts with the verbal questioning she demonstrated during whole class science talks.

When asked direct questions or asked to come up to demonstrate something for the class, Olive frequently acted hesitant or aloof, but surprised Caroline when she started questioning the scientific principles being discussed in the science talk. In the next section of this case study, I will share Olive’s authoring as a hesitant questioner and knowledgeable science learner throughout the Light and Shadows unit.

**Authoring as a hesitant questioner and knowledgeable science learner**

One of the first lengthy interactions Olive had in the Light and Shadows unit occurred with Caroline directly and her classmates indirectly. Olive was chosen to come up to the front of the classroom by Caroline and asked to make a shadow with her body. The following lines of discourse account for the interactions between Olive and Caroline (transcript 1/31/12_2, lines 17-47):

<table>
<thead>
<tr>
<th>17</th>
<th>Caroline</th>
<th>Olive come on up</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Caroline</td>
<td>ok now Olive</td>
</tr>
<tr>
<td>19</td>
<td>Caroline</td>
<td>in order for us</td>
</tr>
<tr>
<td>20</td>
<td>Caroline</td>
<td>I want to make a shadow of you</td>
</tr>
<tr>
<td>21</td>
<td>Caroline</td>
<td>on the screen</td>
</tr>
<tr>
<td>22</td>
<td>Caroline</td>
<td>where do I</td>
</tr>
<tr>
<td>23</td>
<td>Caroline</td>
<td>what do I need to do</td>
</tr>
<tr>
<td>24</td>
<td>Olive</td>
<td>ah</td>
</tr>
<tr>
<td>25</td>
<td>Olive</td>
<td>I don't know</td>
</tr>
<tr>
<td>26</td>
<td>Caroline</td>
<td>well think about it</td>
</tr>
<tr>
<td>27</td>
<td>Caroline</td>
<td>do I see a shadow of you on the screen yet?</td>
</tr>
<tr>
<td>28</td>
<td>Olive</td>
<td>(shakes head no)</td>
</tr>
<tr>
<td>29</td>
<td>Caroline</td>
<td>so what would I need to do in order for that to happen?</td>
</tr>
<tr>
<td>30</td>
<td>Olive</td>
<td>ah</td>
</tr>
<tr>
<td>31</td>
<td>Caroline</td>
<td>get ready to help</td>
</tr>
<tr>
<td>Line</td>
<td>Character</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>32</td>
<td>Olive</td>
<td>I don't know</td>
</tr>
<tr>
<td>33</td>
<td>Caroline</td>
<td>I want you to try first</td>
</tr>
<tr>
<td>34</td>
<td>Caroline</td>
<td>how am I going to make that shadow of you come on the screen</td>
</tr>
<tr>
<td>35</td>
<td>Caroline</td>
<td>I don't see it yet</td>
</tr>
<tr>
<td>36</td>
<td>Caroline</td>
<td>What do I need to do?</td>
</tr>
<tr>
<td>37</td>
<td>Olive</td>
<td>um</td>
</tr>
<tr>
<td>38</td>
<td>Caroline</td>
<td>you can do it</td>
</tr>
<tr>
<td>39</td>
<td>Olive</td>
<td>put the light down</td>
</tr>
<tr>
<td>40</td>
<td>Caroline</td>
<td>Where should I put the light down?</td>
</tr>
<tr>
<td>41</td>
<td>Caroline</td>
<td>down?</td>
</tr>
<tr>
<td>42</td>
<td>Caroline</td>
<td>ok</td>
</tr>
<tr>
<td>43</td>
<td>Caroline</td>
<td>where else?</td>
</tr>
<tr>
<td>44</td>
<td>Caroline</td>
<td>I want it up here</td>
</tr>
<tr>
<td>45</td>
<td>Caroline</td>
<td>I want your shadow to come up here</td>
</tr>
<tr>
<td>46</td>
<td>Olive</td>
<td>put it right here then (Olive points to a different place)</td>
</tr>
<tr>
<td>47</td>
<td>Caroline</td>
<td>ok</td>
</tr>
</tbody>
</table>

Caroline told Olive exactly what she wanted her to do, make a shadow on the screen of herself and asked her what to do to make that happen. Olive’s initial response is “ah, I don’t know” (lines 24-25), which is a curious response for Olive to give as she was on video a few minutes before making a shadow on the wall with her hands (transcript 1/31/12_2). Caroline continued to probe Olive by giving her wait time and asking her in a different way, what should she do. Again, Olive responded with, “ah, I don’t know” (lines 30-32). Eventually, with more prompting, Caroline elicited an accurate response to her question from Olive, but not before Olive hesitated again about her answer (line 37). This vignette demonstrates Olive’s hesitant identity-in-practice and eventual knowledgeable science learner identity-in-practice. Olive never told any of the teachers in the room that she was uncomfortable talking in front of her peers. During an interview with me she mentioned that she felt more comfortable working in her science notebook then participating in science talks (Olive interview, 5/30/12), but due to her raising her hand at times, and asking questions within science talks, nobody thought she was afraid to speak in front of others. That is why I termed her participation pattern as hesitant rather than unsure. Olive clearly displayed a pattern of hesitation within the vignette; however, her hesitation did not mean
she was not thinking or absorbing the content about shadows, which is demonstrated by the accurate placement of hand at the end of the vignette.

As stated earlier, Olive also questioned a lot of the scientific principles discussed in the science classroom. One day the class had a discussion about the difference between reflections and shadows. Olive was asked to demonstrate her shadow and a fellow classmate was asked to demonstrate his reflection with the aid of a mirror. The class was also asked to write about the differences between reflections and shadows in their notebooks. Here is an example of what Olive wrote in her notebook that day, Figure 5-8.

Figure 5-8: Olive’s Reflection and Shadow T-chart

She accurately completed the assignment when she stated, “the reflection is you with colors,” and “the shadow is black.” She did not add any other wonderings or questions in this space. During the science talk that the class was having on 2/21/12, Olive raised her hand and said she saw a reflection and a shadow at the same time. This was a new concept for the students to think about because up until this time, Caroline had only talked about the two words as separate entities. Caroline took this opportunity to ask Olive about her understanding of the two different phenomena represented in the following discourse (transcript 2/21/12_1, lines 52-68):

<table>
<thead>
<tr>
<th>51</th>
<th>Caroline</th>
<th>yes, Olive</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>Olive</td>
<td><strong>when I was (inaudible) at the (inaudible) at the same time I saw my shadow</strong></td>
</tr>
</tbody>
</table>
In this vignette, Olive did not directly question Caroline, but she did bring up something new that none of her peers had talked about before. I would argue that by talking about seeing a reflection and a shadow at the same time she was waiting to see what others would say about her claim. Caroline stopped asking her to explain what she saw as soon as she explained that the shadow she saw was black, which was an accepted definition in this classroom for a shadow. During this sequence of interactions Olive was authoring her knowledgeable science learner identity-in-practice as she explained that she saw a reflection and a shadow at the same time.

Olive continued to push the boundaries of the science talks when she asked on a separate occasion, “If you were in space, floating in the air, would you see a shadow” (transcript 2/22/12, lines 243-245)? Wow, what a great question! Olive clearly understood what was needed to make a shadow from her previous statements and science notebook entries, but in this instance she had a wondering about space. This question allowed Caroline to review some of the components needed to make shadows with the class as she restated the class’s claim for how a shadow is made. Further, it provided Caroline with evidence that Olive was able to apply what she was learning to other contexts. Caroline restated the question a few times and focused the class on the aspect of a surface, and eventually came back to Olive and asked her what she thought. Olive
answered, “if you were in air, you wouldn’t” (transcript 2/22/12, line 357). Olive did not give up with this initial response from Caroline and her classmates. She asked the question again approximately eight minutes later. The following vignette portrays Olive’s identities-in-practice as she authors herself as a hesitant questioner and knowledgeable science learner (transcript 2/22/12, lines 517-548):

517 Olive If you were floating around in space
518 Olive would you see your shadow?
519 Caroline What do you think?
520 Caroline If you were floating in space
521 Caroline would you see your shadow?
523 Olive uh
524 Olive uh
525 Olive no
526 Caroline Why do you say no?
527 Caroline Why do you think no?
528 Olive I don't know
529 Caroline Well think about it
530 Caroline What do you know about shadows?
531 Olive because there would be no surface
532 Caroline there would be no surface
533 Caroline for us to see it
534 Caroline What else
535 Caroline do you think would be a problem?
536 Olive I don't know
537 Olive but if you were near the Earth you would
538 Caroline Why do you think if you were near the Earth?
539 Olive If you were floating in a bubble you might
540 Caroline Where do you think the surface would be
541 Caroline if you were close enough to Earth
542 Caroline from the surface to see the shadow?
543 Olive Earth
544 Caroline the Earth itself
545 Caroline maybe of you were close enough to land
546 Caroline maybe that would be the surface for the shadow
547 Caroline that is where the surface would be
548 Caroline ok

Olive asked again about the possibility of seeing a shadow in space. At first when she responded to Caroline’s questions she answered with, “I don't know,” but eventually took a chance on her own answer. Olive’s answer had conditions in it (“if you were floating near Earth you would”), which displayed her knowledge about the scientific phenomenon her class was
studying. By introducing new questions to the science talks, Olive added to the depth of the discussions and among her hesitations began to practice her identities-in-practice as a knowledgeable science learner and questioner.

Positioning of Olive as a thoughtful questioner and knowledgeable science learner and demonstrator

Caroline did not position Olive as a hesitant learner, but she did work with Olive’s hesitance and did not allow her to give up or accept her answers of “um, I don’t know.” Caroline frequently asked Olive to come up to display a shadow and while doing so, asked her to explain what was happening to create a shadow, or how the shadow was changing as she moved or as the surface or light source changed. For instance, in the following passage Caroline asked Olive to demonstrate how to make a shadow go away (transcript 1/25/12_2, lines 256-265):

<table>
<thead>
<tr>
<th>Line</th>
<th>Speaker</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>Caroline</td>
<td>Olive come on up</td>
</tr>
<tr>
<td>257</td>
<td>Caroline</td>
<td>How can I make my shadows go away?</td>
</tr>
<tr>
<td>258</td>
<td>Caroline</td>
<td>What would you do?</td>
</tr>
<tr>
<td>259</td>
<td>Olive</td>
<td>When you turn that thingy off</td>
</tr>
<tr>
<td>260</td>
<td>Caroline</td>
<td>come show me</td>
</tr>
<tr>
<td>261</td>
<td>Caroline</td>
<td>What would you do to make my shadows go away?</td>
</tr>
<tr>
<td>262</td>
<td>Olive</td>
<td>um</td>
</tr>
<tr>
<td>263</td>
<td>Caroline</td>
<td>There’s a couple things I am thinking of</td>
</tr>
<tr>
<td>264</td>
<td>Olive</td>
<td>unplugging it</td>
</tr>
<tr>
<td>265</td>
<td>Caroline</td>
<td>ok</td>
</tr>
</tbody>
</table>

Instead of accepting Olive’s answer, she asked her to prove it to her by doing it. Olive unplugged the projector after Caroline told her she needed to show her how to make the shadow go away. Caroline invited Olive to show her science knowledge by asking her to demonstrate for the class how to make shadows go away. Olive gave an answer, “unplugging it,” that Caroline was accepting of and asked Olive to show her.

On another day (transcript 1/31/12_2, lines 17-47), Caroline asked Olive to come up again to show how to make a shadow on a screen. Again, Olive responded by saying she didn’t
know what to do, but Caroline prompted her to “think about it” until she had her demonstrate how to create her own shadow on the screen. The relentless positioning of Olive to try things in front of the class to demonstrate her learning persisted against the hesitant identity-in-practice that Olive authored.

Olive’s participation was frequently praised and used as a discussion point by Caroline. I would like to highlight a few of these incidents throughout the Light and Shadows unit. Caroline asked Olive to describe the shadow she made with her own body in the front of the classroom, and before Olive could begin to describe her shadow, Caroline added a layer of importance to what Olive was going to say by telling the class to, “think about what she is saying” (transcript 1/31/12_2, line 107). That small statement added a layer of importance to what Olive was going to say and positioned Olive as knowledgeable among her peers.

The last examples I will use to display the positioning of Olive as a knowledgeable, questioning demonstrator of science knowledge during science instruction came on the last day of the unit when Olive asked the question about seeing shadows in space. Right away Caroline responded with, “good question” (transcript 2/22/12, line 247). Caroline even repeated the question and when she thought students were not listening, asked Olive to repeat the question again and asked the students to listen (lines 258-259). After a few minutes passed, Olive raised her hand again, and this time Caroline stopped what she was saying and explicitly asked the students to give their attention to Olive (transcript 2/22/12, lines 509-519):

<table>
<thead>
<tr>
<th>509</th>
<th>Caroline</th>
<th>Olive</th>
</tr>
</thead>
<tbody>
<tr>
<td>510</td>
<td>Caroline</td>
<td>hold on a second</td>
</tr>
<tr>
<td>511</td>
<td>Caroline</td>
<td>Olive raised her hand</td>
</tr>
<tr>
<td>512</td>
<td>Caroline</td>
<td>You need to come to your spot please</td>
</tr>
<tr>
<td>513</td>
<td>Caroline</td>
<td>Be respectful to Olive please</td>
</tr>
<tr>
<td>514</td>
<td>Caroline</td>
<td>girls</td>
</tr>
<tr>
<td>515</td>
<td>Caroline</td>
<td>eyes on the speaker</td>
</tr>
<tr>
<td>516</td>
<td>Caroline</td>
<td>and it is Olive</td>
</tr>
<tr>
<td>517</td>
<td>Caroline</td>
<td>She has something to say</td>
</tr>
<tr>
<td>518</td>
<td>Olive</td>
<td>If you were floating around in space</td>
</tr>
<tr>
<td>519</td>
<td>Olive</td>
<td>would you see your shadow?</td>
</tr>
</tbody>
</table>
If Olive didn't feel that she could have the floor to ask a question before this incident, she was reminded that what she had to ask was important, not only to Caroline, but to the class as well. Caroline asked for Olive’s peers to have their eyes on her and to be respectful of her as she asked her question. Caroline continued the discussion with the class about Olive’s question until the class seemed to have an answer to Olive’s question.

Throughout the Light and Shadows unit Olive authored her hesitant questioner identities-in-practice. Caroline, however, positioned her in ways that helped Olive feel her questions were valid and her participation was valued, whether hesitant or not, offering a space to author as a knowledgeable demonstrator of science learning.

Daphne’s case: Eager sharer and knowledgeable science learner

In the final case study, I will introduce you to a girl named Daphne. Daphne epitomized active engagement and constructing claims from evidence within the science classroom almost daily. Her case study is rich with evidence that supports the reader in connecting her participation in science class to her eager sharing and using evidence to support her claims and knowledgeable science learner identity-in-practice. Throughout the Light and Shadows unit, Daphne was positioned as a sharer of information, knowledgeable, and capable of extending the science talk in focused directions. Daphne herself raised her hand frequently to share her thoughts and ideas with her peers and teachers, often making connections to her home and community. It is with this introduction I provide you with the elaborate story of Daphne’s participation in the Light and Shadows unit of kindergarten science.
Daphne was a five-year-old kindergarten student at the time of this study. She had an older brother who was also in the same school as Daphne. Daphne’s mother reported that Daphne had varied interests outside of school, which included soccer, riding bikes, singing, dancing, and playing dress-up. She also reported that Daphne talked about science at home, but gave no specifics of what she talked about. When I interviewed Daphne for an end of the year video compilation, she was an eager participant. Throughout the interview Daphne continued to page through her science notebook to show me evidence of what she was saying to me, displaying for me her eager sharer and knowledgeable science learner identities-in-practice. For example, I asked her, who does science? She responded by saying, she does science and began to page through her science notebook to show me all of the different things she did in science class (video, 6/1/12_Daphne). She also told me that scientists talk about stuff, learn things, and measure. She was very adamant that measuring was a part of science and paged through her notebook until she located pages where she measured plant growth and temperatures. I asked her about how she did science and her response was supported with evidence from her science notebook. She said, “I can. I know a lot about it because I see it. I see seeds and I do shadows” (transcript 5/7/12_Daphne2, lines 112-116). As she answered me, Daphne was paging through her science notebook and showing me the investigations she did about seeds and shadows, using evidence to support her claim about being a “doer of science.” Throughout the Light and Shadows unit, Daphne authored her identities-in-practice of being an eager sharer and a knowledgeable science learner striving to connect claims to evidence.

**Authoring as an eager sharer and knowledgeable science learner**

Daphne had numerous interactions with teachers and peers within the Light and Shadows unit, and most of these interactions Daphne initiated by raising her hand during whole group
science talks. During a science talk the class was having about creating shadows by using
different light sources, Daphne raised her hand to answer the question, “In order to see the
shadow what will I need to make sure I do,” Caroline asked the class (transcript, 1/25/12_2, line
451)? Daphne responded to Caroline’s question and told her to turn it on and plug it in (referring
to the lamp) (line 453). Daphne continued to tell Caroline what to do next, “now put something
in front of the shadow,” “right in front of the light,” and Caroline asked her to come up and
demonstrate what she meant (lines 459; 462). Daphne did not stop after Caroline informed the
class she would like them to write down or show pictures about what happened with the lamp and
the shadow. Additionally, Daphne added a new claim to answer another question. Daphne stated,
“when you block it (the lamp light), you can't even see your shadow” (line 476). Caroline
acknowledged that Daphne was providing a claim for an additional question and probed Daphne
for her use of the word blocked (transcript 1/25/12_2, lines 483-487):

483  Caroline  but Daphne finish what you were thinking
484  Caroline  if I blocked what?
485  Caroline  if I block…
486  Daphne  if I block my light (referencing the lamp light) then if you
        look in front of the light you can't even see your shadow
487  Caroline  Ok, so that’s really important to put down in your notebook
488  Daphne  I already did

Daphne responded to Caroline’s question about the word blocked and used evidence to
back up her claim. She showed Caroline what she meant when she took her hand and blocked the
lamplight to show there was not a shadow anymore. She also provided a detailed explanation of
what she observed in her science notebook, Figure 5-9.
In her science notebook, Daphne stated, “You have to get…you can’t see it when you turn it off or block it” (notebook, p20). Within this vignette, Daphne was authoring her eager and knowledgeable identities-in-practice by sharing with her classmates what she noticed from working with the lamplight and her hand. Daphne continued to show her identities-in-practice within the science classroom as she worked in a small group the next day.

On this day the class was asked to investigate shadow position by using a trapezoidal block. Students were given directions for the task, their science notebooks and pencils. As I walked around the different places where students worked I heard Daphne say she could only see half of it, so I stopped and listened to her thoughts (transcript 1/26/12_4, lines 1-13):

<table>
<thead>
<tr>
<th></th>
<th>Daphne</th>
<th>Alicia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I can only see half of it</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>ah ha</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>you did see it</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>and I can see it when</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>I put it like this</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>and as you move it</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Olive did you do the next one?</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>You can't make a shadow go away unless you block it</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Wait</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>What did you say?</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>You can't see a shadow when you block it</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>see (shows herself blocking the light from hitting the block)</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>you can't see it</td>
</tr>
</tbody>
</table>
In this brief dialogue, Daphne thought out loud and shared her new findings with her peers and teacher. Daphne manipulated the block and saw the shadow change as she moved the block. After she explored the new phenomenon, she revisited her previous claim; “you can’t see a shadow when you block it” (line 11). Daphne consistently applied evidence to construct her claims throughout this unit and stated again, “see, you can’t see it,” as she moved her hand in front of the trapezoid to block the light from shining on it (lines 12-13). Daphne not only authored her eager sharing identity-in-practice during this conversation, but also showed her science knowledge by authoring her reasoning for why a shadow could not be seen.

Daphne not only verbally authored herself as a sharer of claims supported with evidence, but she also provided written support of these identities-in-practice as well. As Daphne explored the trapezoidal block she wrote down what she learned from her exploration (Figure 5-10, notebook, p 22-23).

Figure 5-10: Daphne’s explanation of her claims with evidence

On the left page, Daphne wrote, “You can’t see a shadow if you block it,” and on the right page she wrote, “When a shadow is on a different side, it can make a different one” (transcript 1/26/12_6, lines 27-43). When I asked her what she meant by “a different one,” she told me she meant a “different shadow.” Daphne then proceeded to use this claim and evidence from her
science notebook to share what she had learned with her peers during the following science talk

(transcript 1/26/12_8, lines 240-256):

240 Caroline Daphne
241 Daphne Can I show you something on my notebook?
242 Caroline Um huh
243 Caroline I was hoping you would raise your hand
244 Caroline look up here Simon
245 Daphne What I said on this one is I said you can't see a shadow when you block it
246 Daphne because I was holding this like this and when I put it down to my paper I couldn't see that shape
247 Daphne but when I held it
248 Daphne I was holding it like this I could
249 Daphne and I put it like that on the paper
250 Daphne I could see it
251 Caroline so Daphne is noticing that you can't see a shadow when you block it
252 Caroline when you say “block it”
253 Caroline what are you blocking?
254 Daphne I am blocking the shadow because I am making that shadow come into my shadow
255 Caroline hmm
256 Caroline What do you guys think about what Daphne was saying?

Daphne’s explanation of what she put in her notebook prompted Caroline to ask her peers what they thought about her comments, which in turn helped to broaden the science talk with additional pieces of evidence. Daphne used the evidence, her observations in her notebook, to help her explain her claim about blocking the shadow. She also elaborated on her claim when she stated that the shadow came into her shadow. At this point in the unit, Daphne was not clear about what was being blocked and why she couldn't always see a shadow, but this did not stop her from sharing her ideas and claims with her classmates.

In this vignette, Daphne tried to help another peer with an explanation, and even though her explanation was not quite accurate, she tried to explain her thinking by using evidence

(transcript 1/26/12_8, lines 393-404):

393 Caroline Daphne
394 Caroline go ahead Daphne
395 Caroline can you add to that?
Daphne tried to explain her thinking about the sun shining onto her body and coming back up when she saw her shadow. Daphne used visual observations of her own shadow to claim what she said was true, “see, you can see it” (line 404). After Daphne finished talking, her classmates began to use evidence from what they saw to continue the science talk. Daphne was consistent in her endeavor to participate in science talks when she had something to say. Her hand was raised again within the next vignette in response to Caroline’s repetition of a claim Daphne had made earlier about reflections and shadows.

Caroline repeated that Daphne said a reflection was not like a shadow and Daphne responded with her own reasoning for her prior claim (transcript 1/31/12_1, lines 285-292):

Daphne explained to her peers that the difference she was referring to was in a reflection you can see the color of your body (line 288), but when you see your shadow you just see black (292). Daphne continued to demonstrate her understanding of shadows throughout this science talk, even when the topic moved to changing the position of the light source and the object.
Daphne responded to Caroline’s question about what makes a shadow different when she explained how to change Olive’s shadow by moving the light source toward Olive and farther away from Olive (transcript 1/31/12_2, lines 162-187):

162  Daphne  now it’s a shadow and now it’s actually something that I saw
163  Daphne  I saw part of it
164  Daphne  it’s actually when you back it up you can see more
165  Daphne  and when you go
166  Daphne  closer you can only see half of it
167  Caroline  When you move closer
168  Caroline  What do you need to do?
169  Daphne  You need to
170  Daphne  you need to move the light closer
171  Daphne  than you can only see half of her body
172  Caroline  Watch what happens to Olive
173  Caroline  watch her shadow I should say
174  Caroline  now when we move the light backward
175  Caroline  Is that what you were saying, Daphne?
176  Daphne  yes
177  Caroline  Ok, listen to Daphne
178  Daphne  Can I show you with this mirror?
179  Caroline  uh huh
180  Daphne  In the mirror you can see more and then you back up and you can see half my body
181  Daphne  you can't see my face
182  Caroline  and how does your reflection look different than Olive’s shadow?
183  Daphne  It’s cause I’m closer and I can see her more
184  Daphne  I can see her whole body, head, leg
185  Caroline  and what else is different than a reflection and a shadow?
186  Daphne  it’s black and this is color
187  Caroline  oh
188  Caroline  Daphne said that that’s black and this is color
189  Caroline  good
190  Caroline  thank you

Within this vignette, Daphne supported her claim with evidence from the actual exploration in the classroom. Olive is standing in front of the class with a flashlight pointed at her and Daphne described where to move the flashlight in order to change the shadow everyone saw on the screen. Daphne explained that as the light moved toward Olive the less of her shadow they were able to see. Daphne then asked Caroline if she could use the mirror, the tool the students used prior to detect their reflections. When Daphne used the mirror she moved her body back and
forth to show how her reflection changed when she moved in reference to the mirror. Again, Daphne used her participation in the science talk to display evidence and connect it to a claim.

When Daphne did not have evidence at hand she knew where to get it. One day Daphne did not have evidence to support her thinking, but she managed to figure out a way to find some. Daphne entered into the science talk discussion about two shadows being displayed at the same time, where one was lighter than the other one. Her peers discussed their reasoning for why they felt there were two shadows, and she added that she thought the two shadows were next to each other, but then she said, “Um, I could probably find out why its two shadows because my mom has a, um, iPod that when we ask it questions it answers” (transcript 2/22/12, lines 820-826). So even when Daphne didn't have the evidence at hand to support her claim about the two shadows, she quickly found a way to find the answer she needed, supporting her identities-in-practice of the eager sharer of science knowledge while she connected claims to evidence.

Daphne also authored her identities-in-practice when I interviewed her during the last few weeks of school. I asked Daphne questions about participating in class and she responded that she frequently puts her hand up and even if she is not called on she remembers what she wanted to say and raises her hand again to share her thoughts (Daphne interview, 5/30/12). I asked her if it bothered her when people disagreed with what she said and she answered with a negative. Daphne said that she liked when people disagreed with her because it meant that she had a different thought than that person. Daphne’s answers to my interview questions provided me with more evidence to support my understanding of her authoring identities-in-practice of an eager sharer and knowledgeable science learner.
Positioning of Daphne as an eager sharer and knowledgeable science learner

At the beginning of the unit, after I missed a day of student exploration, Caroline wanted to let me know what they had done the day before. Caroline chose to call on Daphne, after she said, “I see two people that can help me remember, can you tell her? (1/24/12_1, lines 22-23) This gave Daphne an opportunity to explain to me what they had done on the previous day and to provide me with the observations they had experienced. This supported Daphne’s identities-in-practice as an eager sharer and knowledgeable science learner, and gave her the floor to demonstrate that.

Daphne received much praise from Caroline on numerous occasions throughout the Light and Shadows unit, which increased her eagerness to share and provide explanations with evidence. As the class was talking about how to make a shadow, Caroline remarked, “See what Daphne did, she did exactly what Job did. She put it up here instead of back here. I think that is really important (transcript 1/25/12_2, lines 468-471). Caroline attached importance to Daphne’s actions and in doing so highlighted the scientific principle Daphne was explaining; where to position the object in relation to the light source.

Again, importance was attached to what Daphne noticed while she worked with her trapezoidal shape and traced the shadows that she saw. Caroline and I both stopped to assess what Daphne said as she worked individually (transcript 1/26/12_4, lines 14-22):

<table>
<thead>
<tr>
<th></th>
<th>Alicia</th>
<th></th>
<th>Alicia</th>
<th></th>
<th>Alicia</th>
<th></th>
<th>Caroline</th>
<th></th>
<th>Caroline</th>
<th></th>
<th>Alicia</th>
<th></th>
<th>Daphne</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Alicia</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>15</td>
<td>Alicia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>16</td>
<td>Alicia</td>
<td>Daphne that is a great thing</td>
<td>that you just noticed</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Alicia</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>18</td>
<td>Caroline</td>
<td>I’m interested in what you are doing</td>
<td>I’m curious about that</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Caroline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>20</td>
<td>Alicia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Alicia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Daphne</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Daphne wrote down what we asked her to (refer back to Figure 5-10) and she shared it in the subsequent science talk that followed the individual notebook work. After she recorded what we asked she continued to add on to her writing to include other phenomena she saw as she explored with the block. After Caroline noticed that Daphne took her advice and wrote down her observations, she approached the class and said (transcript 1/26/12_4, lines 37-44):

<table>
<thead>
<tr>
<th></th>
<th>Caroline</th>
<th>boys and girls I noticed that a few people have said some really interesting things</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>Caroline</td>
<td>about what they are seeing with their shadows</td>
</tr>
<tr>
<td>38</td>
<td>Caroline</td>
<td>and what they’re making</td>
</tr>
<tr>
<td>39</td>
<td>Caroline</td>
<td>so like Daphne is going to write it down</td>
</tr>
<tr>
<td>40</td>
<td>Caroline</td>
<td>so don't hesitate</td>
</tr>
<tr>
<td>41</td>
<td>Caroline</td>
<td>you can write it down</td>
</tr>
<tr>
<td>42</td>
<td>Caroline</td>
<td>what you are thinking</td>
</tr>
<tr>
<td>43</td>
<td>Caroline</td>
<td>that would be helpful too</td>
</tr>
</tbody>
</table>

In this vignette, Caroline positioned Daphne as someone to emulate; Daphne wrote her observations down and it would be helpful if you did this too. When the class came together to have a science talk about the observations they made, Daphne raised her hand to articulate what she saw and Caroline said, “I was hoping you would raise your hand” (transcript 1/26/12_8, line 243). Daphne responded by telling the class about what she noticed and used her notebook as evidence for her claims. Having Caroline respond to Daphne’s hand being raised in such a positive way provided Daphne with the floor to share her observations.

Another example of Caroline attaching importance to Daphne’s statements occurred when the class was having a discussion about reflections and shadows. Caroline commented (transcript 1/31/12_2, lines 160-162), “Daphne said something about a reflection that we saw in the mirror and something that makes a shadow different. Can you tell us what you are seeing now? Listen to Daphne.” Not only did Caroline select Daphne’s work as something she wanted to call attention to and use as an example for the class, she also told the students to listen to Daphne as she explained the differences between reflection and shadow in her own words.
Having a teacher tell the rest of your peers to listen to you gives you the floor and attaches importance to what you are saying because you have been given the space to explain your own thinking. Through these different ways of giving Daphne access to the floor, providing her with praise and encouragement, and allowing her to voice her own explanations, even if they were not always accurate, Caroline created a space for Daphne to try out her claims as she eagerly authored her knowledgeable and sharing identities-in-practice of being a science learner.

The following table (Table 5-1) summarizes the complex identities-in-practice of the participants in this study. A table was made as a heuristic for the reader, but does not in any way suggest that the identities-in-practice of the participants were static in nature. The identities-in-practice of Molly, Josie, Olive, and Daphne were fluid and complex, informed by positioning and authoring, and embodied by the girls within this school science community of practice.
Table 5-1: Table for triangulating assertions from different contexts.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Identities-in-practice</th>
<th>Writing (e.g. science notebook)</th>
<th>Whole group discussion (e.g., science talks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molly</td>
<td>helper, teacher,</td>
<td>-completely answers questions</td>
<td>-frequently responds to Caroline’s questions</td>
</tr>
<tr>
<td>-eager to participate, friendly,</td>
<td>demonstrator,</td>
<td>and prompts in notebook</td>
<td>by raising hand and answering</td>
</tr>
<tr>
<td>talkative</td>
<td>persistent science</td>
<td>-helps others by showing them</td>
<td>-adds on to Caroline’s requests with her</td>
</tr>
<tr>
<td></td>
<td>leaner</td>
<td>her notebook as an example</td>
<td>own thoughts extending Caroline’s directive</td>
</tr>
<tr>
<td>Josie</td>
<td>demonstrator,</td>
<td>-minimally completes prompts,</td>
<td>-doesn’t raise hand often</td>
</tr>
<tr>
<td>-hesitant and quiet, but eager</td>
<td>capable science</td>
<td>one drawing</td>
<td>-asks to show an example of the phenomenon</td>
</tr>
<tr>
<td>to share non-science related</td>
<td>learner, doubtful</td>
<td>-asks a lot of questions</td>
<td>during the science talk, but is unsure of</td>
</tr>
<tr>
<td>stories</td>
<td>about answering</td>
<td>about prompts before she begins</td>
<td>her answers when asked questions</td>
</tr>
<tr>
<td></td>
<td>questions</td>
<td>-created science story as a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>choice</td>
<td></td>
</tr>
<tr>
<td>Olive</td>
<td>questioner, demonstrator,</td>
<td>-completely answers prompts in</td>
<td>-frequently says um, or I don’t know before</td>
</tr>
<tr>
<td>-hesitant and quiet, doesn’t</td>
<td>knowledgeable science</td>
<td>notebook</td>
<td>answering a question correctly</td>
</tr>
<tr>
<td>raise hand often</td>
<td>learner, hesitant</td>
<td>-doesn’t add anything else to</td>
<td>-asks questions that are new and “outside</td>
</tr>
<tr>
<td></td>
<td></td>
<td>her entries</td>
<td>the box”</td>
</tr>
<tr>
<td>Daphne</td>
<td>sharer, knowledgeable</td>
<td>-completely answers prompts in</td>
<td>-frequently and persistently raises her hand</td>
</tr>
<tr>
<td>-eager to participate, talkative</td>
<td>science learner,</td>
<td>notebook</td>
<td>to be called on to answer</td>
</tr>
<tr>
<td></td>
<td>connects claims to</td>
<td>-adds additional explanations</td>
<td>-adds evidence to her explanation while</td>
</tr>
<tr>
<td></td>
<td>evidence, eager</td>
<td>from evidence to her entries</td>
<td>talking with the whole group</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-brings in new resources for obtaining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>evidence or explanations</td>
</tr>
</tbody>
</table>
Chapter 6

CROSS-CASE FINDINGS AND DISCUSSION

This chapter presents my assertions from the study as they relate to theory and findings from the study and cases. The discussion, intertwined among the assertions, will emphasize what was learned from studying girls’ access to reform based science instruction in the kindergarten classroom.

One may ask while reading this study, how does studying identity effectively relate to answering questions about learning in a classroom? As previously mentioned in Chapter 2, the social practices of science interact with specialized ways of talking, writing, and engaging in the world. The social groups construct the norms and expectations that are part of belonging to this school science community. Therefore, the study of identities-in-practice within this complex context, and the study of how the discourses of school science knowledge are constructed are both included in the examination of interactions and practices of members within the community.

As Wortham stated, “By exploring how people actually use sociocultural tools in practice, social scientists have given empirical accounts for how processes like social identity and academic learning intertwine” (2006, p.15). When kindergarten students enter a classroom for the first time, they have presupposed identities, but the environment in the classroom on that first day has not directly acted upon these identities. The teacher in the classroom has an idea of what identities the students may bring from home, but she has not established norms or routines for the students at this point in time. So when the students come into the classroom the students’ identities are more likely to be represented by sociohistoric models and less likely to be presupposed due to local events. However, after a few weeks or months, local practices within the community of learners
begin to have an impact on behaviors mediated through classroom and teacher expectations (Wortham, 2006).

As a researcher who sees learning as socially mediated, whereby individuals learn within a community of others, through the passing on of shared artifacts and discourse related to their context and mediated by all participants, studying identity in this space intertwines with learning, as the way an individual is positioned or positions themselves will have an impact on the learning community. As the individual begins to take up the discourse of the community, they begin to author different identities-in-practice. Paying attention to how this happens has direct connections to planning “personal pedagogies” and curriculum for future students (Wortham, 2006).

Understanding the girls’ identities-in-practice throughout the Light and Shadows unit constructs and is constructed by their engagement with, and access to, the science learning that was provided to them. These ideas are unpacked within the assertions I have developed from my study.

**Identities-in-practice manifests differently in different literacy practices (whole group discussion, written work) and shows how students chose to be science students across time and activities** A focus on one literacy practice alone is insufficient to understand identity.

Notable are the scientific identities-in-practice that emerged as the young girls were called upon and how those differed from the participation offered in their written work. For instance, Molly’s science notebook contained completed pages of drawings and text. She followed the directions Caroline announced and she completed each task when asked. Like Olive, she didn't add additional questions or comments to her notebook. She also completed each task asked of her without adding her own wonderings or additional text. This differed from Olive’s identities-in-practice in whole group science talks. By looking at these differences, researchers and educators can note that there are differences between contexts in which students perform or
participate subject to their comfort level. Varelas, et al., (2008) found that this occurred in the study that she and her colleagues conducted with young children and science and literacy practices. Their research team noted the identities of students changing from moment to moment and that identity is not a singular attribute placed upon somebody, but that it is enacted differently in different spaces (Barton et al., 2008; Carlone, et al., 2011; Gee, 2001; Varelas, et al., 2008).

During science talks, Olive began by hesitating and negating her knowledge by frequently saying, “I don’t know,” even though the writing in her science notebook would prove otherwise. Another point of interest that differed for Olive was her questioning identity-in-practice. On a few occasions within whole group discussion, she asked tangential questions that allowed Caroline to push the class’s thinking and asked them to apply their knowledge about the phenomenon; however, these questions were never captured in Olive’s science notebook within the Light and Shadows unit. This brings to light the viewpoint that identity is personal, that it may be performed in different ways subject to the author’s feelings of connectivity to the subject matter or material and the ways on which the author experienced that subject before (Gallas, 1998). Observing and analyzing Olive’s actions, discourse, and writing over time, albeit a small timescale, provided me with the opportunity to unpack her developing school science identities-in-practice (Barton, et al., 2008; Barton & Tan, 2010; Brickhouse, et al., 2000; Brickhouse & Potter, 2001; Lave & Wenger, 1991; Tan & Barton, 2007a; Tan & Barton, 2007b). These developing school science identities-in-practice would not have been discovered through just looking at Olive’s written notebook entries because she completely answered all of the prompts and never wrote anything extra. But in the whole group environment, Olive was choosing her affinity for space to ask questions related to the phenomenon of light and shadows. At a cursory glance, Olive would have appeared to be non-engaged most days with science, as she played with her hair on the carpet and answered Caroline’s initial questions with pauses and “I don’t knows.”
However, when looking across the data, Olive takes up knowledgeable school science learner identities-in-practice.

As for Josie, she struggled to complete the tasks that were asked of her in her science notebook and maintained that struggle during whole group science talks as well. Her notebook did not contain a lot of text or drawings and she could be heard asking questions during whole group times as Caroline was giving directions. Her identities-in-practice of a demonstrator and capable science learner were not replicated in the writings within her science notebook, which left Caroline wondering how much Josie was learning during the unit. This provides another place for contemplation about the usefulness of looking across contexts (Varelas, et al., 2008). Josie aptly took on a doubtful identity-in-practice for most of the days in science class. She did try to fit into an affiliation with science, as she continuously tried to show she knew what was happening with the phenomenon by demonstrating with materials and showing Caroline that she understood, but she was not as adept at speaking science or writing science. Josie performed her identities-in-practice throughout the first three units, and as theory indicates (Holland, et al., 2001; Lave & Wenger, 1991; Wortham, 2006), she was situated in the science community trying to become part of the community as a novice, learning from experts (teachers), and the community around her. Theory helps us to see that Josie was trying on a school science identity. Furthermore, this study helps us see that even though Josie did not maintain her science notebook or answer a lot of direct questions from Caroline, she was still trying to understand the phenomenon and show others that she understood.

Ultimately, Daphne posited synchronous identities-in-practice in both spaces; the science notebook and the science talk/whole group discussion. Daphne consistently, when called upon, shared her claims with the class and supported her claims with evidence. When she made a new claim, she often reasoned why her claim was accurate and provided evidence for her idea. She also did this in her science notebook. Daphne added new claims and evidence to areas within her
science notebook and used this information during science talks. Daphne affiliated with science from the beginning of science class. She knew something about everything (Gallas, 1998) and that connection to the material and content helped her to perform and author sharing and knowledgeable school science learner identities-in-practice. Researchers have documented that a person’s comfort with the subject matter has an impact on their performance (Shulman, 1986), whether it be teachers or students. However, looking at Daphne’s case does provide additional insight into the connections that she is making with the science practices and her school science discursive identity (Brown, et al., 2005), and how having an array of knowledge helped her to perform those identities-in-practice at different times in the classroom during science instruction. Taking this space away, whether it be the whole group discussion or the writing, would not have provided Daphne with areas in which to author her identities-in-practice (Brickhouse & Potter, 2001; Tan & Barton, 2007a; Tan & Barton, 2007b), and that would not help the field of science education in any way with their understanding of science learning.

Each of the case study girls had a different way to demonstrate their identities-in-practice within the individual space of science note booking and not all of them demonstrated these same identities-in-practice within whole group science talks. As Lave and Wenger (1991) suggest, learning science is a process of developing identities-in-practice. Giving the girls different contexts in which to try on their identities, allowed the girls to demonstrate their positions within the learning environment. As they were working on becoming more central in the learning community, the girls were practicing the discourse for this specific learning community in different ways and “trying on” new identities (Wortham, 2006). The girls in this study demonstrated their identities-in-practice as they participated, either minimally or fully with obtaining information, constructing explanations, and communicating information from their science notebooks to their peers in an attempt to either question and/or share their understandings of the science content, which is so important to study in this manner because it highlights the
subtleties in looking across contexts and time. Caroline provided the space in which girls, and all students, could offer their identities-in-practice by means of the different contexts within the scientific classroom community, and this needed if researchers, policy makers, educators, and others are going to look at what makes a productive and knowledgeable scientific community.

The ways in which the teacher positions girls, especially “quiet girls,” is essential for engaging them in productive participation in science discourse and learning. This contributed to shaping identities-in-practice.

As Barton, Tan, and Rivet note, “How students are positioned in the science classroom also shapes identity development” (2008, p. 78), along with how they position themselves and their already fluid identity. Caroline was working within the space of the CER framework and the Light and Shadows unit, which required pedagogical content knowledge, ample amounts of time, and science content knowledge. Caroline often deliberately chose her talk moves, her questions, her investigations, and the length of her science talks in order to increase student learning and participation. Unintentionally, at times, and at other times quite intentionally, she chose who to call on and how to probe them for deeper understanding of the content (Davies & Harré, 1990).

Caroline frequently would praise the case study girls for their efforts after having asked them a question and they answered it. She would not stop asking Olive and Josie for their help in answering questions even after they responded without an answer the first time the question was asked. She continued to prompt them and gave them wait time, or asked them if they would like to have a friend help them with the answer. Whereas, Caroline could have moved on when Olive continuously replied with “I don't know,” she didn’t accept that as an answer and continued to probe Olive by asking reworded questions or more specific questions to elicit answers from her.

When Olive asked a question or posed a different phenomenon than what the class was discussing at the moment, Caroline could have dismissed what Olive was saying and moved
along with her own questioning. This may have given Olive the feeling that she was not allowed to ask questions not directly related to the question being asked. Caroline did not, however, and allowed and placed value on what Olive was asking or noting as an important question or statement.

By allowing Daphne to share with her classmates and express herself by using evidence to support her claims, Caroline was highlighting the importance of the use of science practices in scientific learning. She was, in turn, discursively positioning (Brown, et al., 2005; Davies & Harré, 1990; Varelas, et al., 2008) the girls by showing them how scientists act or ask questions during their own science talks. She could have asked Daphne for a single word response, but she did not, even though her time for science in the classroom was limited.

Caroline continued to place importance and emphasis on science talks in the classroom and allowing time for her students to explore new phenomenon. By giving the floor to the girls, allowing them to bring their science notebooks to the science talk, and giving them time to talk about their wonderings and claims, Caroline positioned the girls and the class as science learners and legitimized the time they spent on the co-construction of science knowledge (Zembal-Saul, et al., 2013).

The methods and deliberate decisions that Caroline made in giving the floor to the girls or allowing them to demonstrate their knowledge in ways that they felt comfortable with may have impacted their view of what learning science looks like in a school (Varelas, et. al, 2011). The girls, and other students in the class, were introduced and consistently shown local models for science practices in this kindergarten CER space, and in turn had the opportunity negotiate their identities-in-practice within this context throughout the year.

Without observing and analyzing the positioning involved in the day to day events that occurred in Caroline’s classroom, I would not have been able to define the trajectories of the identities-in-practice of the four girls. Researching positioning, coupled with identity, provides
the scientific community with a way in which to look at the take up of the scientific literacy practices, and in this case more specifically the classroom science instruction with a focus on explanation building with evidence. A study like this has not been performed before with such a fine grain focus on CER and kindergarten girls, which are nuanced in what they bring to the elementary classroom as novices. Knowing how to use talk moves to help the students work through their explanations and using phrases like, “I wanted you to raise your hand and share what you found,” helped the girls in the study to recognize that what they were doing was science and to legitimately practice science (Duschl, 2000).

A focus on classroom science instruction grounded in constructing explanations from evidence provided a consistent framework for students’ writing and talking, which facilitated the establishment of expectations and norms of participation for all students.

All of the girls participated in some way throughout the Light and Shadows unit. The unit was designed to give students access to the phenomenon in an investigative way. Big questions were asked of the class and these questions were designed to allow every student in the class to have access and opportunity to explore evidence and consider their own ideas about how to answer these questions. Caroline’s use of the CER framework helped provide this consistency to the science learning community. By always beginning with a question to investigate, students knew the ascribed practice would be to investigate, ask questions, record observations, and co-construct claims in the production of a science talk, where bringing your own ideas and questions was valued (McNeill, et al., 2006; Zembal-Saul, et al., 2013; Zembal-Saul, 2009).

As norms were established for this science community, the girls were shown what it looked like when someone participated in this science community, and they chose how they would like to participate and demonstrate their knowledge-building within this space. Olive and Josie were initially chosen as case study girls because they were quiet and minimally participated
while the norms of the school science community were being created. However, these two displayed different identities-in-practice throughout the Light and Shadows unit. As Barton, Tan, and Rivet (2008) posit in their research, new opportunities present themselves to try on a different identity when a new topic of interest is introduced, among other situations. We see this happen in the Light and Shadows unit with Josie and Olive.

Josie remained quiet throughout the unit in whole group science talks; however, she did use the time when Caroline gave her the floor to demonstrate her science knowledge to Caroline and her peers. Consequently as mentioned before, Josie and Olive, when asked a question by Caroline frequently answered by saying, “I don’t know,” or “um.” This would occur until Caroline probed deeper, and ultimately, Olive would answer the question correctly or ask a question of her own. Part of using the CER framework with young children (Zembal-Saul, et al., 2013) requires the teacher to be diligent in not only understanding content knowledge, but also the pedagogical practices (Shulman, 1986; Zembal-Saul, et al., 2013) that help to support the framework and student learning.

As the class began exploring the phenomenon, additional questions and investigations were added; this was not part of the explicitly stated CER framework, but it was indirectly a practice used during the creation of a KLEW chart (Hershberger, et al., 2006), an artifact used to support the thinking around the CER (Zembal-Saul, et al., 2013). For instance, the word “reflected” was creeping into student’s vocabulary and it was being used synonymously with the way the light source affected the shadow. At one point, Caroline wasn’t sure if the students were using the terms to describe what they saw or as a way to describe the light, so she added an additional investigation to the unit focusing on reflections and shadows.

Caroline deliberately wanted to have students talk about what they were seeing as someone stood in front of a mirror and if it was the same thing that students saw when a flashlight was aimed at a student standing in front of the white board. Caroline wanted to give her students
another experience with the phenomenon. From this additional experience, students can view that being a scientist means that when you aren't sure about how to explain a phenomenon, you test it against your other ideas, discuss it with your peers, and write about your thoughts in your science notebook. Because Caroline added an additional day in which the students wrote in their notebooks about what they were thinking or drew what they saw as a reflection and a shadow, adding evidence to their science notebooks to support their claims in an authentic way was mandated. Without these opportunities to explore and ask questions freely, or to draw and/or write about their own thinking, Caroline’s students would not have had numerous opportunities to interact with the phenomenon and practice ways of doing science.

Olive was shown by example that adding to the science community was valued. She continually added additional questions to the whole group science talk, even as a quiet and sometimes hesitant science learner. She was able to author an identity-in-practice as a knowledgeable questioner of science. In analyzing these girls more closely, it should be noted that as quiet, introverted girls, their identities-in-practice were demonstrated as introspective and personal. They either displayed what they knew about the science content or produced questions that were meaningful to them about the science content. They did this in a space that was open to their ideas and sharing, no matter how they chose to do it.

The other girls, Molly and Daphne, were chosen because they were frequently participating in science talks and the developing of norms in the science community. They demonstrated a more extroverted identity upon initial consideration and maintained this identity-in-practice throughout the Light and Shadows unit. Both Molly and Daphne had their hands up frequently during whole group science talks, and when someone else would be called upon, they lowered their hands until the person was finished speaking, and then raised their hands again.

Molly eagerly helped Caroline by answering questions and helped her peers by showing them the writing in her notebook or her drawings. Daphne, also eagerly participated when
Caroline gave her the floor, but she did so differently than Molly. Daphne’s responses to Caroline included evidence to build upon her claims. She would use evidence from class, from her everyday out of school experiences, and from the schoolyard. Daphne would apply different pieces of evidence to her claim as she responded in class. Daphne was frequently building on to what others said prior to her and demonstrated her science knowledge by effectively communicating her ideas. Daphne was allowed the space to do this based on the framework being used in this class as well as how Caroline structured science instruction. Daphne’s answers were valued and given importance throughout the unit because she embodied the principles of the CER framework; she used evidence to support her explanations (Duschl, et al., 2007; McNeill, et al., 2006; NGSS lead states, 2013; Zembal-Saul, 2009; Zembal-Saul, et al., 2013).

Caroline’s use of the CER framework allowed her to introduce some of the social practices of science with her kindergarten class and, in turn, gave more opportunities to the case study girls to explore their identities-in-practice. As stated before in this research study, girls are traditionally positioned with less power (Brickhouse & Potter, 2001; Sadker & Sadker, 1995) in science and this may affect their idea of what it means to do science, as well as, who can do science. In this classroom, the girls were not positioned with less power because all students were encouraged to support their claims with evidence, and given the floor to do so.

All students were asked to make observations of the phenomenon in their science notebooks throughout a variety of investigations. All students were allowed access to the different resources within the classroom and asked to use these resources to demonstrate their understanding of the phenomenon. All students were told to sit around the carpet and asked to think about how they could answer the big science question. Each of the practices of science allowed access for every student to demonstrate their knowledge building, and Caroline supported each and every student in this endeavor. If a student didn’t know how to write what they wanted to write, like Josie, Caroline gave them an alternative; draw a picture instead.
If a student didn't write or draw a picture to demonstrate their learning, then they could demonstrate their learning at the science talk by verbally explaining their claim, evidence and reasoning, and vice versa. If a student didn't feel comfortable talking in the whole group, they still had a space to demonstrate their knowledge about the science content within their notebook.

Caroline did a productive job guiding students in the beginning of the year with the creation of their specific norms of practice for this kindergarten science community. Caroline used CER pedagogies to help her students understand and participate in science knowledge building. By using the CER framework as a common, socially constructed practice, Caroline was able to lead the students in asking questions and producing wonderings, exploring and investigating the phenomenon in question, and sharing their evidence with each other as the class co-constructed claims to answer the questions they were pondering. By doing this, Caroline made students aware of the resources and practices that were available and supported in this community. Just as Barton, Tan, and Rivet (2008) noticed with middle school students, the links between what the girls know, what they can do, and how they chose to use their knowledge and skills, helps to reveal their identities-in-practice. The identities-in-practice of Olive, Molly, Josie, and Daphne were authored in various ways throughout the study. As they chose to participate or not, as well as, the way they participated, showed how most of them took on different identities in different contexts, and how these identities informed, supported, or confronted their demonstrated learning in class.

The teacher in this study provided a variety of opportunities to the girls, and all students in this class, to co-construct their claims about the phenomenon as well as to develop their identities-in-practice by giving them local meanings for what it means to do science. Caroline allowed students to have a safe space in which to ask new questions, explore new materials, question the phenomenon, and to communicate their ideas and questions with each other. As a result, the research study was able to include new findings about kindergarten girls’ identities-in-
practice and their access to science teaching and learning within their kindergarten science community. In order to better understand student science learning, you need to look at the individual and the community as they co-construct science knowledge (Brown, et al., 2005).

This study, informed by the situated learning theory and sociocultural perspectives on learning (Greeno, 2006; Lave & Wenger, 1991) provided the community with research to back up the claim that by using the common, socially constructed practice, the CER framework, helped students, like Olive and Josie, to find a place in the science learning community that valued them and their learning. By providing all learners with unique opportunities to construct their own or co-construct their claims and provide explanations that combine the claims, evidence, and reasoning, gives students an opportunity to participate in the practices of science in ways that work for them and the community (Lave & Wenger, 1991). Students are surrounded in the community of science learners, and how the expert, or teacher, chooses to proceed in that community has a direct connection to how the students will be able to practice their own developing scientific identities, even with young learners who can do science.

Important assertions were made from this study concerning girls and their access to classroom science instruction with a focus on explanation building with evidence. First, the identities-in-practice of the girls being studied about would not have been fully observed if they were only given one literacy practice in which to work and demonstrate their knowledge. If Caroline had conducted her science class with only explorations and notebook writing, then we would not have seen the performance of some identities-in-practice, namely the questioning identity-in-practice. Also, the positioning that Caroline enacted with the girls in the class throughout their science instruction helped to provide support for the enactment of the girls’ identities-in-practice. Caroline probed the girls with continuous questions, even after they tried to back out of answering. She encouraged them to share their claims, and allowed them take the
floor and ask their own questions and demonstrate their own learning. Positioning the girls this way helped them to try on different identities as they learned how to be part of the scientific community. Utilizing the CER framework consistently during science instruction and developing norms of practice that all students could enact as they practiced science helped to provide a space where all students could participate, especially the girls who might not have participated otherwise. Using the CER framework helped to demonstrate to students the practices of science and gave them a way to practice their embodied identities within the context of science. There are important implications for teaching, research, and policy that can be garnered from this research. In the following chapter, I will explicate the implications from this study, and suggest areas for future research.
In this study, I set out to examine the following research questions: a) How are the norms of participation co-constructed within Caroline’s kindergarten classroom? b) How are kindergarten girls authoring themselves (as science learners) within this classroom? c) How are the kindergarten girls positioned (as science learners) within this classroom? and d) What are the girls’ developing identities-in-practice? I investigated these questions by becoming a participant observer in Caroline’s kindergarten classroom for the 2011-2012 school year. While I was there, I recorded video of the science classroom instruction, semi-formally interviewed students and teachers, photographed student artifacts, and took ethnographic field notes. I analyzed the aforementioned data with iterative methods, as I transcribed video and constructed event maps (Kelly & Chen, 1999), constantly compared codes (Strauss & Corbin, 1998) from one data source to another, and utilized the ethnographic research cycle (Spradley, 1980).

I was motivated to begin this study by my own personal experience, grounded in what I knew from the literature and how I was positioned in a science class. I had a difficult time understanding the reasons why I had a lower participation grade than my male classmates and why my professor didn't call on me in a class with four students. I began thinking about science instruction and how I was positioned within the class. If the science instruction that I received had been framed in the practices of science (instead of containing rote memorization, and mainly lecture), maybe I would have had more opportunities to learn Herpetology.

While science education reform measures call for “Science for all” (Duschl, et al., 2007; NRC, 2011), and educators read, decipher, and try to implement new standards designed to help
with the complex nature of science and engineering disciplinary core ideas and practices (NGSS lead states, 2013), we are still facing difficulties in supplying the STEM workforce with employees, specifically women (U.S. Dept. of Commerce, 2011). Whereas society concludes that women’s under representation may be due to factors such as gender stereotyping, lack of women role models, and work place disparity, science education researchers argue that the lack of girls in science could stem from their experiences in school science classrooms (Barton, et al., 2013; Brickhouse, et al., 2000; Carlone & Johnson, 2007). Elementary school science has suffered from a focus on accountability measures in language arts and mathematics. This new focus coupled with teachers’ self-professed lack in content knowledge, pedagogical content knowledge, and anxiety to teaching science (Marx & Harris, 2006) exacerbates the dilemma of increasing science education instruction. Drawing from theories of sociocultural learning, positioning, and identities-in-practice I examined norms of classroom science instruction and crafted case studies of Molly, Josie, Olive, and Daphne to tell their stories of participation and identities-in-practice within the kindergarten classroom.

The norms of practice were co-constructed by the members in the science community of practice; led by Caroline as the more experienced other (Lave & Wenger, 1991). By grounding this study in the theoretical lenses of identities-in-practice and positioning, I was examining the discourse of the school science community and it’s participants. This framing positions the study to examine specific actions taken by Caroline and her students within the classroom community. Thereby, the study does not look beyond the community of practice and what “counts as science” beyond this community. If students participated in ways that were not negotiated by the school science community in this study, then their participation was not accounted for.

As part of this school science community, Caroline deliberately used talk moves (Michaels, et al., 2008) to facilitate science talks and give students a way to participate in the explanation building process of school science. The students helped to create an environment
where they could listen to each other talk and agree or disagree with each other based upon their own evidence. Caroline used writing structures, such as KLEW charts (Hershberger, et al., 2006), to accommodate learners that needed to use visual representations in their learning. She frequently used words or phrases to talk about what scientists do in connection to what the students were doing in the classroom. By doing this Caroline showed students that what they were doing in their kindergarten classroom was compatible with the practices of “real” scientists. Caroline’s enactment of school science may have provided a limitation for some learners, as not all learners are as comfortable or capable in performing in linguistic, verbal, and logical ways.

Caroline, an experienced facilitator with the CER framework, asked questions, designed investigations for students, and elicited explanations from her students while emphasizing their claims, evidence, and reasoning. The way that Caroline instructed the class and the way that the students were able to contribute to the school science community allowed for the girls in her class to practice their developing school science identities-in-practice (Carlone, et al., 2011; Lave & Wenger, 1991; Tan & Barton, 2007a; Tan & Barton, 2007b). This happened in different ways, as the girls chose when to author their identities-in-practice within the different science literacy practices afforded to them by their membership in the school science community. Caroline’s positioning of the girls as knowledgeable and capable science learners through different talk moves and ways of providing them with the floor encouraged the girls with their developing identities-in-practice as a demonstrator, helper, teacher, questioner, and sharer, and knowledgeable science learner.

The case studies illustrated the ways in which four young girls participated in the norms of explanation-based science instruction, each in their own way, where what counts as evidence in science is observable and/or collected data from primary or secondary sources. Molly was a consistent teacher, helper, and demonstrator during science instruction. She authored her identities-in-practice as a teacher, helper, and demonstrator of science knowledge to her
classmates and to Caroline. Molly was also consistent as a science learner as she participated readily both in whole group science talks and while writing observations or notes in her science notebook. Josie was not as consistent with writing in her science notebook, but she did participate in science talks and chose to author her identity-in-practice as a demonstrator of science knowledge. Olive fluctuated between a hesitant and confident questioner throughout the Light and Shadows unit. She frequently answered questions with an initial, “um, I don't know,” but she also asked questions for the students and teachers that were extensions of the phenomenon that the class was studying and showcased her knowledgeable science learner identity-in-practice. Olive was frequently positioned as knowledgeable and was asked to demonstrate the phenomenon in question. Daphne authored herself as an eager sharer of explanations and science knowledge. She always had her hand up, ready to participate. Daphne shared her new claims and evidence with her peers regularly, and constantly added ideas to her science notebook.

Cross-case analysis yielded three major assertions that contribute to the literature in important ways. First, identities-in-practice manifest differently in different literacy practices (whole group discussion, written work) and shows how students chose to be science students across time and different contexts. A focus on one literacy practice alone is insufficient to understand identity. This is important to understand when planning science curriculum and instruction in an early elementary classroom. Some of the girls in Caroline’s class were avid writers and were able to practice their school science identity in this way, whereas one girl was not an avid writer and she was able to demonstrate her learning by showing how the phenomenon worked during whole class science talks. Having different literacy practices available to students helps them to express their learning and identity in a variety of ways. Again, Caroline and her students created particular ways of being and acting in this classroom that valued understanding science that could be tied to verbal expression and logical thinking. Such an approach defines what counts as science in this manner.
The ways in which the teacher positions girls, especially “quiet girls,” is essential for engaging them in productive participation in science discourse and learning. This can contribute to shaping identities-in-practice. The teacher in the study used talk moves and scientific discourse to engage students with the phenomenon. She would not let the girls answer “I don’t know” without prompting them and giving them wait time in order to think about their ideas. This was integral for the developing identities-in-practice the girls were enacting. Positioning girls as science learners helped the “quiet” girls find a space to participate, and they asked questions and demonstrated their knowledge in the learning community.

A focus on classroom science instruction grounded in constructing explanations from evidence provided a consistent framework for students’ writing and talking, which facilitated the establishment of expectations and norms of participation for all students. Using the CER framework provided ample space for girls to take up the practices of science in their own ways. Having a consistent approach to learn science gave girls the opportunity to build their school science identity within the norms of practice of this community.

In conclusion, the girls in this study authored a variety of identities-in-practice for science learning through classroom science instruction focused on explanation building with evidence. They were able to participate in the norms of the science classroom, and while doing so gained exposure to science practices. These girls were also able to work on their identities-in-practice as they wrote in their science notebooks, participated in whole group science talks, and became part of the science learning community.

These assertions have important implications for ways in which science is taught in elementary school, the science education community, science education research, and education communities. This study uses evidence to illustrate the learning, practices and burgeoning identities-in-practice of kindergarten girls as science learners, and in so doing adds to the body of research regarding identity. This study is different than others that have been conducted because
it focuses on kindergarten girls in a science classroom community where science instruction focuses on explanation building with evidence. The science education research community has conducted various studies about girls and science and identity (Barton, et al., 2008; Brickhouse & Potter, 2001; Carlone, et al., 2011; Carlone, 2004; Tan & Barton, 2007a; Tan & Barton, 2007b), but these studies have not looked at kindergarten girls. Kindergarten girls offer valuable insight into beginning identities-in-practice that develop as girls are introduced to the science classroom environment.

This study provides research about the connection between teacher positioning and authoring of kindergarten girls’ identities-in-practice. It is important for teachers, policy makers, and researchers to consider the positioning and authoring of young students as they create curricula, create and support new laws, and develop professional learning opportunities because it is essential to create these new or revised artifacts and practices with a focus on sociocultural learning. This study provided insight on how examining the positioning and authoring of girls as science learners by analyzing discourse highlighted their identities-in-practice as different types of science learners.

This study also provides the research community with evidence supporting the ways in which different school science identities-in-practice are embodied over time in a kindergarten classroom where the science instruction was focused on explanation building with evidence as a common, socially constructed practice. Kindergarten students participated in the practices of science and were successful in co-developing explanations supported by a structure of claims, evidence, and reasoning. Science educators should take this evidence and think about what it means for how we develop curriculum materials and assessments for young children in science.

This study provided evidence that showed how a teacher co-constructed norms of practice in her science classroom, knowing that she was using a common, socially constructed practice, the CER framework, to encourage participation from all of her students. This has
implications for professional development communities and universities that develop elementary science methods courses. The instructors of methods’ courses and professional learning opportunities should find evidence from this study that supports what kindergarten school science students are capable of when being immersed in CER. Preparing future and in-service teachers for reform-based practices should be moved to the forefront within their contexts. These entities should use the evidence provided to reflect upon their own efforts with science based reform measures and take additional action, if needed, especially with the early elementary community, where so few students think that young children can “do science.”

Educators in the research community and/or in practice should look to this study as a way to support early elementary science education. This study showed a way to implement different literacies across disciplines as a means to giving students a way to participate in the learning community. Students in this study were given different ways to present their science learning, which helped to provide the girls in the study a way to express their different identities-in-practice. This study has implications for the education community at large, specifically ELL instruction in science, as we try to consider all students and their engagement with learning. Providing students with different learning opportunities, not solely based on discourse, helped to showcase the fluidity of the identities-in-practice of the girls in this study. If the girls were only provided with science talks as a way to participate in science, some of them would not have demonstrated additional identities-in-practice that occurred during investigations or while they were working independently, writing in their science notebooks.

Young girls are capable and interested in science and deserve opportunities to participate and author strong science identities. They are explanation builders and question things out of this world. They deserve to be given opportunities for science learning and should be the focus of our research community as it looks to move beyond the twenty-first century.
Future research

This study provided me with an opportunity to observe and analyze the kindergarten science classroom. When I was in this classroom as a participant observer I was able to interact with the participants in the community. I would have liked to have longitudinally followed these students as they proceeded through their elementary grades to observe how their views of science changed or remained the same. Research should focus on the impacts that students’ early elementary science instruction has on their science identities-in-practice, as research has told us that by middle school or even upper elementary school girls are less interested in science (Carlone, et al., 2011).

I also believe it would be valuable to conduct research in another kindergarten classroom where the science instruction is grounded in practices of science to compare the positioning of the girls as science learners and authoring as such with a similar classroom like Caroline’s where science instruction was focused on explanation building with evidence. Doing this research could shed some light on the importance of curriculum and pedagogical strategies in science.

Intensively studying the teachers’ preparation and professional learning opportunities longitudinally could also shed light onto the present research study. Examining kindergarten teachers’ struggles with the implementation of reform-oriented science practices and which practices were more difficult for teachers to implement could provide the research community with insight into the preparation and continual professional learning opportunities that should be created for education professionals. Longitudinal explorations would be a welcomed addition to understanding why the teacher chose the talk moves that she did, and how intentional or unintentional her positioning of the girls was in her science classroom.

Standardized testing and minimized time for science and social studies instruction in elementary classrooms has become a national problem. What will we do when we don’t have a
teaching force that supports reform-based science instruction in elementary classroom? Where will young children’s curiosity be encouraged and supported? A recent workshop was endorsed by the National Research Council, which focused on the overlap between NGSS and Common Core (Pearson, Aguilar, Michaels, Moje, Primentel, & Quinn, 2014). This workshop concluded that there are similarities that exist between the two reform documents; primarily the practice of obtaining, evaluating, and communicating information. This study provides evidence that showcases kindergarten girls’ performing that very practice. With a nation that reports on the decreasing numbers of girls interested in science and STEM careers (National Academies, 2007), we need to refocus our attention on our youngest learners and their capabilities and participation with science, and the integration of science with other core disciplines. If we take science instruction away from them because we are focused on literacy and math alone, we are losing an opportunity to support their science identities-in-practice, which may continue to increase the lack of girls’ participation in science. “Illuminating” young girls’ participation and developing identities in the reform practices of science supports a focus on young girls’ access to science and brings this topic of research from the shadows into the light.


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Appendix A

Parent/Guardian Questionnaire

May 3, 2012

Greetings~

A few months ago, I embarked on a research project in your child’s kindergarten classroom. Part of this project includes gathering some information about your child in out of school settings. Earlier this year, I sent home and received a signed consent form from you indicating your willingness to participate in completing this parent survey. As stated on the consent form, “You will be asked to complete a questionnaire containing 5-10 questions pertaining to your child in the study. When you have answered the questions, you will be asked to return them to your child’s classroom teacher in the marked envelope provided. The answers to these questions will provide the researcher with background knowledge about your child and will be confidential and stored in a locked filing cabinet and password protected file.”

Please answer the following questions to the best of your ability. If you need to skip one or more questions, that is okay.

Child’s name: _______________________________________

Child’s age: ________________

Does your child have any siblings?   Y/N

If yes, could you please list the relationship(s) and age(s) of the sibling(s)?
Example: Brother 10 y/o, Sister 4 y/o

Was this your child’s first experience in an educational classroom?   Y/N

If no, please list your child’s prior experience in an educational classroom.
Example: Billy went to ABC for pre-school for 3 years.

What are your child’s afterschool routines, activities, hobbies, and/or interests?

If you stated one of your child’s routines, activities, hobbies and/or interests as science-related, could you please elaborate on this item?
Example: Does your child conduct his/her own science investigations, observe nature, visit museums, draw what he/she sees occurring in the world, take care of pets, etc.

Have you ever heard your child talk about what he/she has been doing in science this year?

Y/N

If yes, please explain (to the best of your ability) the content of the conversation.
Example: Billy was excited about the Face Time chat with Mrs. Dillon’s class and told us about it at dinner that night. He mentioned his classmates discussing living and nonliving things.

Name of parent(s)/guardian(s) completing the questionnaire: _______________________

Thank you for completing this questionnaire. Your answers will provide insight for this research project and be kept confidential. Sincerely, Alicia M. McDyre (axd252@psu.edu)
## Appendix B

### Light and Shadows Content Storyline

<table>
<thead>
<tr>
<th>Questions</th>
<th>Claims</th>
<th>Evidence</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where does light come from?</td>
<td>Light comes from light sources.</td>
<td>Sources of light are sun, light bulbs, candles, lanterns and fire.</td>
<td>Reading, prior experience, science talk, notebook</td>
</tr>
<tr>
<td>Can we see without light?</td>
<td>We need light to see.</td>
<td>In a dark room, without light, we cannot see anything.</td>
<td>Reading, prior experience, science talk, notebook</td>
</tr>
<tr>
<td>How are shadows made? When do we see shadows?</td>
<td>Shadows are made when something blocks light.</td>
<td>We could see a shadow when the light was on. We could not see a shadow when the light was off. When you move the shadow moves with you.</td>
<td>Projector and objects</td>
</tr>
<tr>
<td>When don’t we see shadows?</td>
<td>“A shadow is a place where the light cannot reach.” A shadow cannot be made when there is not a light source or the source is scattered.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scientific principles: Light travels in a straight line and things interact with light by absorbing it. A light source, an object and a screen.
Appendix C

First page of IRB proposal

Submitted by: Alicia McDyre
Date Submitted: August 19, 2011 2:19:11 PM
IRB#: 37551
PI: Alicia Marie McDyre
Review Type: Exemption
Protocol Subclass: Social Science
Approval Expiration: -pending-
Class Project: No

Study Title

1>Study Title  Girls as science learners in an evidence-based elementary science classroom
2>Type of eSubmission  New

Home Department for Study

3>Department where research is being conducted or if a student study, the department overseeing this research study.  Curriculum and Instruction

Review Level

4>What level of review do you expect this research to need? NOTE: The final determination of the review level will be determined by the IRB Administrative Office. Choose from one of the following: Exemption

5>Exempt Review Categories:
Choose one or more of the following categories that apply to your research. You may choose more than one category but your research must meet one of the following categories to be considered for expedited review.
[X] Category 1: Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods. (This category may include children. This category may NOT include prisoners or be FDA-regulated.)
Appendix D

IRB approval

Date: September 01, 2011

From: The Office for Research Protections - FWA#: FWA00001534

Stephanie L. Krout, Compliance Coordinator

To: Alicia M. McDyre

Re: Determination of Exemption

IRB Protocol ID: 37551

Follow-up Date: August 10, 2016

Title of Protocol: Girls as science learners in an evidence-based elementary science classroom

The Office for Research Protections (ORP) has received and reviewed the above referenced eSubmission application. It has been determined that your research is exempt from IRB initial and ongoing review, as currently described in the application. You may begin your research. The category within the federal regulations under which your research is exempt is:

45 CFR 46.101(b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Given that the IRB is not involved in the initial and ongoing review of this research, it is the investigator’s responsibility to review IRB Policy III “Exempt Review Process and Determination” which outlines:

- What it means to be exempt and how determinations are made
- What changes to the research protocol are and are not required to be reported to the ORP
- Ongoing actions post-exemption determination including addressing problems and complaints, reporting closed research to the ORP and research audits
- What occurs at the time of follow-up Please do not hesitate to contact the Office for Research Protections (ORP) if you have any questions or concerns. Thank you for your continued efforts in protecting human participants in research. This correspondence should be maintained with your research records
Appendix E

Student Interview Protocol for Video Prompts

Thank you for allowing me to talk to you today. You don’t have to help me if you don’t want to. Would you like to help me by sharing your ideas? You can stop talking with me if you want to, and we’ll go back to your classroom.

Are you willing to share your ideas with me? (If child says YES, say “Thank you for your help.” If child says NO, say, “That’s fine. Let’s go back to your classroom now.”)

Interviewer initials for verbal assent ______

I am trying to understand how children think and learn about science. I am really interested in your own ideas, not what anybody else thinks.

1. While you are watching this video of your science classroom can you tell me what you see/hear yourself doing/saying? Please explain.

2. Why are you doing/saying that? Please explain.

3. Can you describe how you were feeling at that moment? Please explain.

4. Can you remember what the class was talking about or thinking about? Please explain.
Appendix F

Student Questions for End of Year Interview

1. What are the three pages you picked in your notebook to show me today?
2. Why did you pick these?
3. What are you most proud of with these pages?
4. Do you remember what we were talking about in class before you completed this (go over each) page?
5. What do you do in science class?
6. What do you like most about science class?
7. What do you not like about science class?
8. What is science, how would you describe it?
9. Who does science?
10. What do people do when they do science?
11. Do you do science?
12. How do you do science?
13. When do you do science?
14. Who is good at science in this class, why?
VITA

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EDUCATION

The Pennsylvania State University, University Park, PA
Ph.D. Curriculum and Instruction, Science Education; August 2009-August 2014
Dissertation: Kindergarten girls “illuminating” their identities-in-practice through science instruction framed in explanation building: From the shadows into the light

Shippensburg University, Shippensburg, PA
M.S. Biology; August 2004-May 2007

The Pennsylvania State University, Harrisburg, PA
M.Ed. Curriculum and Instruction; August 1998-May 2003

Shippensburg University, Shippensburg, PA
B.S. Biology with secondary teacher certification; August 1994-August 1998

SELECT PRESENTATIONS


• McDyre, A., Dillon, S., & Jeffries, J. (2013, April). “Catch me if you can! ” says the Gingerbread bear: Kindergarten students “run, run, run” to collect evidence while writing the “recipe” for science talks. Presented at the annual conference for the National Science Teacher’s Association, San Antonio, TX.

TEACHING EXPERIENCE

The Pennsylvania State University, University Park, PA; August 2009-present
Central York School District, York, Pa; October 1998-August 2009