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CONNECTING SCHOOL SCIENCE AND STUDENTS' EVERYDAY LIVES

By

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ABSTRACT

CONNECTING SCHOOL SCIENCE AND STUDENTS' EVERYDAY LIVES

By

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Science education faces two major challenges: the perceived relevance of science to people's everyday live and ensuring that all students can obtain high quality science instruction. This dissertation explores how making connections between school science and students' everyday lives can lead to higher quality science education. It explores how a class of 4th grade students makes connections between school science and their everyday lives. Drawing on a sociocultural perspective, I conceptualize learning as entering into a community of practice. I investigate how the affordances and constraints of three activities shaped students' opportunities to learn. In particular, I examine when and how students and teachers drew on students' funds of knowledge and created hybrid spaces. To this end, I examine 1) the object of the activity – the task and its' parameters, and 2) the participation framework – how the students and teacher are positioned in the activity and the discourse structures. I discuss how the object of the activity and the participation framework and the interaction between the two aspects provided opportunities for the students and teacher to make connections between students' funds of knowledge and school science and merge them to create hybrid spaces. I conclude with a discussion of the themes that arose from the study and the implications for teaching and learning.

To Ms. Walker and her 4th grade class. Thank you for welcoming me into your classroom and your lives. This would not have been possible without you.

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CHAPTER 1

Situating the study

Two major, intertwined challenges face science education: 1) the perceived relevance of science to people's everyday lives, and 2) ensuring that all students, regardless of age, sex, socioeconomic status, or cultural or ethnic background, can obtain high quality science instruction. The National Research Council (NRC) and the Association for the Advancement of Science (AAAS) purport that students must be scientifically literate because people need to use scientific information to make choices in their everyday lives. Furthermore, they need to be able to engage in public discourse about issues that involve science and affect society (AAAS, 1993; NRC, 1996). Since everyone needs to use science in their everyday lives and everybody should have access to quality science instruction, the term "science for all" has been coined as a goal of K-12 science education (AAAS, 1990).

If "science for all" is the goal of science education, how can this goal be achieved? What does this look like in K-12 schools? How can science be taught to all students, regardless of their background? What "science" do students use and interact with in their everyday lives? While "science for all" is a goal, there remains a disconnect between school science curriculum and instruction and science that students use in their everyday lives and all students are not receiving high quality instruction (Brickhouse, 1994; O. Lee & Fradd, 1998). One way to address these issues is to study more about what and how students learn outside of school. In other words, what science do students learn about and use in their everyday lives? How do students learn outside of school?

How can we draw upon students' knowledge from outside of school and use it as a bridge to teach them science in school?

From a sociocultural perspective, the norms, values, and practices of particular cultures shape one's learning, identity and behavior. Learning science does not require simply acquiring facts and skills; it entails learning to think and act within a community (Fradd & Lee, 1999; Lave & Wenger, 1991; O. Lee, 1999; E. B. Moje, Collazo, Carrillo, & Marx, 2001; Rosebery, Warren, & Conant, 1992). As Lee (1999) states, "From the sociocultural perspective, learning science involves learning to think, talk, and act as a member of the science community. It also involves developing the values and beliefs shared in the science community" (p. 189). Gee (2005) uses the term "Discourse" "...for ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity" (p. 21). He capitalizes the "D" in Discourse to distinguish it from discourse, or how language is used. In other words, discourse is one aspect of a Discourse. Some who adhere to a sociocultural perspective of learning describe learning as entering into various Discourses (e.g., Moje et al., 2004).[1]

Individuals learn many discourses and Discourses over the course of a lifetime, and science should be one of them. School science, particularly in urban schools, is often very different from students' everyday discourses and Discourses. For example, Moje and her colleagues (2001) describe how the word "quality" is used differently in students' everyday lives compared to how the teacher uses it when teaching students about air and water quality in science class. Lee (1999) discusses how students' cultures are often very

[1] I would like to have a discussion about Discourse, community and culture during my proposal defense. I would like the committee's insight into how they view the various terms.

different from the culture of science. These differences may be incompatible, or discontinuous, and may create barriers to learning science. For example, entering into the science community may prove difficult because the judgment standards of a scientific community may vastly differ from students' communities. In other words, the differences between lay thinking and scientific thinking may be problematic when attempting to learn how to think scientifically (O. Lee, 1999).[2] Students must learn how to negotiate these differences. Thus, "Teachers have the difficult role of serving not only as transmitters and facilitators, but also as bridges between academic content and students' languages and cultures" (Fradd & Lee, 1999, p. 16). This is no small task, as Lee and Fradd (1998) acknowledge five components of science learning: knowing science (scientific understanding), doing science (scientific inquiry), talking science (scientific discourse), scientific values and attitudes, and scientific world view.

While Lee and Fradd (Fradd & Lee, 1999; O. Lee, 1999; O. Lee & Fradd, 1998) discuss how cultures can create barriers to learning science, Warren, Ballenger, Ogonowsi, Rosebery, & Hudicourt-Barnes (2001) think of the relationship between culture and learning in terms of continuity, as opposed to discontinuity. They state, "This work does not assume a simple isomorphism between what children do and what scientists do; rather, it views the relationship as complex and taking a variety of forms: similarity, difference, complementarity and generalization" (p. 531). Instead of focusing on the ways in which children's thinking is different from those in the scientific community, Warren and her colleagues focus on how it is similar and attempt to draw on those similarities. In other work, Rosebery, Warren, and Conant (1992) conceptualize

[2] In this paper, I will sometimes use community and culture interchangeably because communities are held together by common cultural practices, beliefs and values.

learning in terms of scientific literacy, or learning the discourse of science. From their study they find that students could use their own native languages to talk about science and to help them negotiate the scientific discourse. Similar to others, Rosebery and her colleagues assert that learning science does not require simply acquiring facts and norms; it entails learning to think and act within a community.

Aikenhead and Jegede liken learning science to border crossing (Aikenhead, 1996; Aikenhead & Jegede, 1999). They view science as a subculture of Western culture.[3] Students negotiate crossing borders between their everyday worlds outside of the science classroom to the subculture of school science. Aikenhead and Jegede suggest that learning science can be a process of enculturation or assimilation. If the subculture of science harmonizes with a student's culture, learning is a process of enculturation. When science is at odds with a student's culture and attempts to replace or marginalize a student's culture, then learning science is a process of assimilation. Hogan and Corey (2001) also discuss how learning science can be a process of enculturation when it takes students beyond the boundaries of their experiences to become familiar with new ways of talking and knowing. But in their study, they find that "...students and scientists do science for different purposes and in radically different contexts" (p. 238). Students resist some of the scientific practices and norms the teacher-researchers attempt to teach the students. Thus, the idea that we can teach students to "be scientists" in K-12 schools is flawed. While Hogan and Corey to not explicitly mention the dangers of learning science as a process of assimilation, they state:

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[3] Aikenhead (1996) draws on Phelan, Davidson, and Cao's (1991) definition of culture: the norms, values, beliefs, expectations, and conventional actions of a group.

> An extremely important tool for airing different values and perspectives on scientific sense-making is classroom discourse... Through open, mindful dialogue with students we can gain insight into their cultural and epistemological perspectives, then work toward creating learning situations that give them access to tools of a specialized community of practice, while respecting the vitality and priorities that they bring to the cross-cultural exchange. (p. 239)

Hogan and Corey implicitly suggest that in order for learning science to be a process of enculturation, teachers must respect the cultures or Discourses[4] that students bring into the science classroom.

While various researchers who take a sociocultural perspective on student learning view learning through slightly different lenses, in general, they agree that learning science involves entering into a community or culture of science. These researchers agree that learning involves more than just cognitive processes that occur inside one's brain; learning is socially constructed. Entering the science community requires learning the ways of thinking, talking, and acting in the science community. Gee (2005) would assert that it involves learning the Discourse of science. Because students' cultures or Discourses may be different than the community of science that students are learning to enter (i.e., what and how students learn), there may be a disconnect between school science and students' everyday lives. Aikenhead and Jegede's (Aikenhead, 1996; Aikenhead & Jegede, 1999) ideas of enculturation and assimilation are particularly useful in thinking about science learning as a process that can either build on and expand, or alienate students' everyday cultures or Discourses. Since the goals of science education

[4] I use the terms cultures and Discourses here interchangeable because, in my opinion, Aikenhead, Jegede, Hogan, Corey and Gee use the terms in similar manners.

are for students to use science in their daily lives and for all students to receive equitable and quality instruction, this raises the question: How can we build on and expand students' everyday cultures or Discourses to *include* the culture or Discourse of science?

Research Questions

My dissertation aims to investigate students' funds of knowledge as a means of investigating student learning and learning how to better connect science to students' everyday lives. My research builds on existing research in sociocultural studies in science education, "funds of knowledge," and "third space." I am interested in students' experiences with the material world and how these experiences mediate their learning in school. I seek to address the following questions:

- What funds of knowledge regarding the natural world do students have regarding animals and their habitats?
- How do students draw upon these funds of knowledge in their science classroom? In other words, how do these funds of knowledge shape their meaning making in school settings?
- How does the teacher draw upon these funds of knowledge in the science classroom?
- How does the teacher and students create third/hybrid spaces?

Conceptual Framework

In order to address this question, I draw upon three conceptual tools: 1) a sociocultural perspective of student learning to understand why a disconnect exists between school science and students' everyday lives, 2) "funds of knowledge" as a way to bridge the disconnect between science learning and students' everyday lives; and 3) "third or hybrid spaces" to think about the space where students' everyday and school knowledge and practices intersect.[5] Since a review of sociocultural perspectives was provided in the introduction, in this section I will discuss the scholarship on funds of knowledge and third space.

Funds of knowledge and Discourses

A "funds of knowledge" framework helps me investigate how to connect the cultural knowledge and practices of students with school content knowledge and practices. It privileges students' knowledge and practices in their daily lives; it views learning as a process of enculturation. The scholarship on funds of knowledge provides a model for how students' who are traditionally underserved in school can receive quality instruction and connect science (literacy, mathematics, etc.) to their daily lives.

Moll and his colleagues (Gonzalez, Moll, & Amanti, 2005; Moll, Amanti, Neff, & Gonzalez, 1992) refer to funds of knowledge as historically accumulated and culturally

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[5] It is important to note that, while the concepts of funds of knowledge and third space come from slightly different disciplines or lineages (the former from cultural-historical theory and the latter from sociolinguistics), both are considered sociocultural perspectives. I mention "a sociocultural perspective" as a separate conceptual tool as a means to talk about the general sociocultural ideas of student learning, which involves learning various beliefs and practices in order to enter into a community.

developed bodies of knowledge and skills essential for household or individual functioning and well-being. This includes knowledge from community practices, labor practices, and family practices. Inspired by Vygotsky's cultural-historical psychology, funds of knowledge emphasizes how cultural practices and resources mediate the development of thinking. A "funds of knowledge" framework helps one investigate how to connect the cultural knowledge and practices of students with school content knowledge and practices. Research on funds of knowledge focuses on *practices* – what households actually do and what they think about what the do – as opposed to culture. Gonzalez (2005) theorizes the limitations of culture by stating, "The concept of culture emphasized in schools has focused on how shared norms shape individual behavior and on discovering standardized rules for behavior" (p. 40). But households do not necessarily adhere to shared norms; they are more complex. Therefore, Gonzalez goes on to state that in the research on funds of knowledge, they take:

> ...processual approaches to culture that take into account multiple perspectives... Processual approaches focus on the processes of everyday life, in the form of daily activities, as a frame of reference. These daily activities are a manifestation of particular historically accumulated funds of knowledge that households possess. Instead of individual representations of an essentialized group, household practices are viewed as dynamic, emergent, and interactional. (pp. 40-41)

In other words, households draw on multiple cultural systems. Examining household practices goes beyond culture because it allows for variability within populations – hybridity – as opposed to simply variability between populations. It places emphasis on fluidity of practices that is context dependent, as opposed to static in nature. Similarly,

students draw on multiple practices from multiple contexts, and the knowledge they learn from these various practices mediates what and how they learning in school. Therefore, it is important to determine various practices from outside of school and inside of school that students draw on while learning in school.

While Moll and his colleagues initiate the research on funds of knowledge, Moje and her colleagues (E. Moje et al., 2004) and Calabrese Barton and Tan (in preparation) build and expand upon the funds of knowledge work in two important ways. Moll and his colleagues assume that what they learn about adults inform them about children. Moll (2005) recognizes the limitations of their methodology, as children might not hold the same funds of knowledge as their parents. Moll and his colleagues interact with parents that choose to engage children in particular funds of knowledge, but not others. In addition, they recognize that children often create their own social worlds and funds of knowledge irrespective of adults' social lives. Moll explicitly points to the importance of investigating the latter point – students' funds of knowledge from their own social lives. Thus, the first contribution that Moje and her colleagues and Calabrese Barton and Tan make to the funds of knowledge scholarship is in their methodology; they interact directly with students in order to study their funds of knowledge. Along with family funds of knowledge, they examine peer, community and popular cultural funds of knowledge. Moje and her colleagues argue that students spend a significant amount of time participating in various practices that involve peers, the community, and popular culture, and that the knowledge gained from these practices constitute funds of knowledge. They consider knowledge from these practices funds of knowledge because these funds mediate student learning. Second, they broaden funds of knowledge to

include Discourse. They discuss how students' funds of knowledge shape their Discourses, or ways of thinking, knowing, believing and acting. They study how students draw on various funds of knowledge in various contexts.

Similar to all of the funds of knowledge scholarship, I view funds of knowledge as embedded in practices/activities. In addition, I believe that it is important to examine the context of activities and how the context shapes the activities and how knowledge is formed. I draw on the more expanded view of funds of knowledge and Discourses that Moje and her colleagues and Calabrese Barton and Tan use. Limiting funds of knowledge to household practices excludes many important communities that students participate in that shape how they think, believe and act.

While science education attempts to teach students how to become part of a science community, individuals participate in many communities outside of school. Thus, students bring many funds of knowledge and Discourses from these various communities into the science classroom. Since one of the goals of science education is for students to connect science to their daily lives, educators need to *recognize and build upon* students' funds of knowledge and Discourses from various communities in their school classrooms. In order for this to happen, researchers and teachers must first determine students' funds of knowledge and Discourses.

Third/Hybrid Spaces

Gutierrez and her colleagues' (1995) concept of "third space" is useful in conceptualizing how community knowledge and school knowledge come together. By drawing upon students' funds of knowledge in school classrooms, teachers can help

create a "third space" where the "first space," students' community knowledge, values, and beliefs, merge with the "second space," those of formal institutions such as schools (K. Gutierrez, Rymes, & Larson, 1995; E. Moje et al., 2004). Students bring many funds of knowledge into the classroom that shape how they learn. Thus, it is essential to create a space in formal schooling that facilitates the merging of their inside and outside of school knowledge and learning.

Gutierrez and her colleagues (1995) were the first to use a theory of third space in education. They drew on Bahktin's theory of heteroglossia and conceptualized third space as the place where the teacher script (official space) and the students' counterscript (unofficial space) came together in the classroom to create a transcendent script, or true dialogue. But in their classroom study, they found that third spaces rarely occurred because the teacher did not privilege the students' counterscript. In other words, the teacher did not acknowledge the students' funds of knowledge and Discourse that they brought into the classroom.

Moje and her colleagues (2001) described how, when the teacher in their study drew on the students' experiences, he was better able to help students navigate competing Discourses (community and school Discourses) and generate new Discourses that included the scientific Discourse. In other words, he was able to create what Moje and her colleagues called a congruent third space. In her later work, Moje and her colleagues (2004) connected the theory of third space to theories of hybridity. They suggested three views of third space: third space as a bridge between community and home-based Discourses to school-based Discourses; as a navigational space where students crossed between various discourse communities (related particularly to the discursive boundaries

posed by different disciplines); and as a transformative space where Discourses merged and created new Discourses. Calabrese Barton and Tan (in preparation) used Moje and her colleagues' (2004) theories of hybridity and showed how third or spaces were created and how the classroom was transformed physically, politically, and pedagogically.

All of the research on third space used ethnographic methods. The context of the classrooms was especially important in understanding when and how third spaces were or were not created. In other words, it was crucial to examine how context determined *what counted* as knowledge in classrooms. Also underlying all of the work on third space were issues of power. Gutierrez and her colleagues explicitly discussed how power needed to shift from the teacher to the students in order to create a third space where the students and teacher co-constructed their experiences. This required teachers to acknowledge and privilege students' funds of knowledge and Discourses. Moje and her colleagues and Calabrese Barton and Tan agreed that teachers needed to draw on and privilege students' funds of knowledge and Discourses in order to create third spaces. All of the researchers on third space argued that creating third spaces not only helped bridge students' community and home-based Discourses, but it also created transformative spaces where new Discourses could be created.

Thus, the research on third space views learning as a process of enculturation, as opposed to assimilation. Viewing learning as a process of enculturation requires seeing curriculum as dynamic and fluid. As Gutierrez and her colleagues (1995) assert, "Redefining curriculum as social practice forces the abandonment of monologic instruction and provides the social and cognitive rationale for including and constructing multiple forms of knowing" (p. 469). Curriculum should be constructed by the teacher

and students through a reflexive process. It should draw on students' funds of knowledge and Discourses so that students can connect science (literacy, mathematics, etc.) to their everyday lives. Through this approach, students' ways of knowing from many communities are valued. Furthermore, learning occurs when new hybrid Discourses are created. Creating third spaces in classrooms not only help students connect science to their everyday lives, but it also is an approach that can provide quality instruction for all students.

Overview of Dissertation

In this chapter, I provided background for my study. I laid out the importance of my study, described the conceptual tools that guide my research and introduced my research questions.

In Chapter 2, I describe the methods that I used to conduct this study. This chapter includes a description of the context of the study, including the school and participants. I explain how I generated data, the types of data I generated, and the framework I used for my data analysis.

I present my findings in Chapters 3, 4, and 5. Each chapter represents the analysis of one activity. In each activity, I describe how the object of the activity and the participation framework was established, negotiated, and reinforced. Further, I demonstrate how the object of the activity and the participation framework provided various opportunities for students to draw on their funds of knowledge and create hybrid spaces.

In the final chapter, Chapter 6, I summarize the findings from Chapters 3, 4, and 5. Then I discuss themes and implications that arose from the findings. Finally, I present the limitations of the study.

CHAPTER 2

Methods

> But when describing institutions of his or her own society, the ethnographer must adopt the critical stance of the philosopher, continually questioning the grounds of the conventional, examining the obvious, that is so taken-for-granted by cultural insiders that it becomes invisible to them. Often it is the taken-for-granted aspects of an institution that in the final analysis turn out to be most significant. (Erickson, 1984, p. 62)

In studies of teaching and learning the challenge is, as Erickson states, to make the familiar strange. In this study, I used ethnographic methods to investigate how the students and teacher drew on students' funds of knowledge in science activities. Ethnographic methods were appropriate, as I aimed to pay attention to how participants constructed and made meaning of their worlds and lives (LeCompte & Schensul, 1999).

In this chapter, I first describe the context of the research, which includes the school, the surrounding neighborhood, the principal, teacher, and students. I also address my role as a researcher. Then I discuss the data I collected which includes field notes, audio, video, interviews, and student and school artifacts. Next, I describe my data analysis, which includes a discussion of how it evolved throughout the analysis process. Finally, I provide a brief overview of the three activities that I analyze in this study.

Context and Participants

Setting and gaining entry into research site

During the 2006-2007 school year, I was a participant observer in a 4th grade classroom in an urban school in the Midwest, located near a large state university. I chose to work in a fourth grade classroom because it afforded me the opportunity to observe the same group of students learning different subjects (e.g., science, mathematics, reading) and there tended to be more integration of subjects and fluidity of time in elementary school classrooms than often found in middle and high schools. I also felt like I would have more access to students in other settings, such as after school programs. Older students sometimes work after school jobs or play sports.[6]

A fellow graduate student provided me with an initial contact teacher in the school district. The teacher was working with the university as a mentor as part of an induction program study. She knew many of the elementary school teachers in the district in which I was interested in conducting my research because she worked as a gifted specialist in a pull-out program for the district's elementary schools. I told her that I was interested in working with a teacher who was open to me studying how students made connections between their experiences and practices inside and outside of school. She put me in touch with Ms. Walker, a teacher at Walden Elementary School.[7]

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[6] I was not interested in studying students in sports settings because I was more interested in students' everyday experiences that might be related to the life sciences.

[7] Pseudonyms are used for all participants and the school.

Walden Elementary School

Walden elementary school was a Title I school, serving primarily minority students from low-income households. It was a science, math and engineering magnet school where staff fostered an environment that encouraged and supported science learning. There was a science specialist and a science lab where students would sometimes go to engage in science lessons. The lab had a large open area where students would sit in a circle on the floor to have science talks and listen to directions for activities. There was also an area with lab tables and chairs where students would conduct their science activities. All of the students at Walden were issued white lab coats that they wore when they went to the lab and sometimes when they learned science in the regular classroom. They also wore lab coats when special visitors came and when they had assemblies.

Because Walden was a magnet school and received money from a grant, it had programs that one might not find at other urban schools that served minority, low-income students. The school was involved in recycling program with the city and a city worker came to talk to students about recycling twice a year. They had recycling bins for paper in every classroom along with bins in one of the hallways for plastic bags, boxboard, Styrofoam, athletic shoes, and batteries. There was a worm bin to compost food waste and students used worms from the worm bin to feed the school turtle. In addition to the regular worm bin, a 5th grade class built a solar worm bin so the worms would survive the cold Michigan winter and the school could compost year round. Ms. Walker's 4th graders did a unit on hydroponics, students had experiences with robotics in multiple

grades, and there was a broadcasting program where 4th and 5th graders did a daily morning school news show.

In the spring, the school had a career day where people who work in various science, math, and technology related careers such as a veterinarian, a horticulturist, a zookeeper, an engineer, a beekeeper, and a naturalist came to talk to students about their jobs. The school also had funding from their magnet grant for a number of field trips. Students participated in weeklong field trips to the local zoo and overnight trips to a nature center located about an hour away from the city. Through the money provided by this grant, Ms. Walker's class went to a nearby nature center daily for one week as part of their ecosystems unit. Walden offered after school programs such as newspaper, chess, tutoring, and computers. Thus, the students were provided with a variety of science and engineering experiences at Walden, and science and technology were encouraged and emphasized. This was not a school where "being smart" was discouraged as, in my experience, can sometimes be the case at some urban schools. During my time spent at Walden, my general impression was that the students seemed excited about science and enjoyed doing science activities. This supported what Ms. Walker told me the first time I met with her.

Many of Walden's parents were also very involved in the school's efforts to create an atmosphere that supported science learning. One example of this was parental involvement in service at the school. Students' parents were expected to perform 10 hours of service for the school. A handful of parents went above and beyond 10 hours. Some parents would help organize fundraising events, help out at family nights,

chaperone field trips, and organize class parties. One parent came to school at least once a week to help clean the coral tank in the science lab.

Neighborhood

The school is located in the southwest side of the city. It is located off a major road and is surrounded by houses and apartment buildings. Along the main road, there are fast food restaurants and markets. Some students came from the surrounding neighborhoods, while others were bused from different parts of the city. Immediately adjacent to the school are modest homes. One student lived directly across the street from the school, but moved part way through the year to a house in a safer neighborhood. He told me that people in his old neighborhood would wander in the streets in the evening and once there was a shooting and a bullet hit his house. Ms. Walker built a butterfly garden during the 2005-2006 school year, but over the summer the garden was completely destroyed by vandals. During the year I spent at Walden, the students built a pond. One evening, someone or a group of people vandalized the pond area. They threw rocks and dead birds in the pond and trampled on the plants.

Principal

Walden Elementary had a well-respected principal. Mrs. Samson, an African American woman, maintained a good relationship with students, parents and teachers. She knew the students by name and could tell you about each student's family. When there were behavior problems, she took the time to get to the bottom of the problem

before she determined consequences. Mrs. Samson was very open to forming community partnerships and allowing research in the school because she thought that it helped improve the quality of teaching and learning. She was very dedicated to the students, teachers, and families of Walden. She promoted family after-school activities such as the Thanksgiving Dinner and Valentine's Day Family Night, and "Are You Smarter Than a Walden Star?" and sometimes spent her own money to fund of these events.

Teacher

Ms. Walker, a white female, was in her 5th year of teaching. She had grown up in a small town north of the city, attended the nearby state university, and earned her degree in elementary education. She spent her first two years teaching English at a middle school in the same school district and then moved to Walden Elementary. 2006-2007 was her 3rd year at Walden. Ms. Walker was working on her master's degree in literacy instruction at a nearby university. Even though she was extremely busy, she welcomed me into her classroom. She admitted that science was not her area of expertise but she enjoyed teaching it, particularly the plants unit because she loved gardening in her free time. She was very willing to let me work with the students in any manner that I desired. Throughout the year, she would ask me to help individuals or groups of students with science, math, reading, etc. She also solicited advice on how to teach various science topics, we occasionally planned lessons together, and we would often discuss other teaching issues such as behavior and classroom management.

Students

There were 30 students in Ms. Walker's 4th grade class: 17 boys and 13 girls. 83% of the students were minorities (73% African American, 10% Asian or Hispanic, 17% White)[8]. 68% of the students in the school were eligible for free or reduced-price lunch. I also selected a focus group of 5 students (2 girls and 3 boys) in order to gain a more in-depth understanding of the student' funds of knowledge and how they drew on these in school. These students were chosen with help from Ms. Walker to represent a range of academic ability and engagement in schooling, following the first few months of the school year.[9]

Role of the researcher

As with any researcher, I bring my experiences and perspectives to the research I conduct (Erickson, 1984). These experiences and perspectives shape who I am as a person, teacher, and researcher. I am an Asian American woman with a bachelor's of science in biology and a master's degree in science education. For as long as I can remember, I have enjoyed science and the outdoors. I am a teacher who has taught informal environmental education on a barrier island and science to low-income, primarily African American students in a public urban middle school. I am interested in issues of equity and social justice in education; I hope that the work I do in some way helps improve the quality of education for traditionally underserved populations.

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[8] African American included children who are of mixed ethnicity, but are identified as African American on school forms. White included one student from Bosnia and one from Iraq.

[9] I did not include descriptions of the focus students because I did not focus on them in my analysis.

I was an active participant in Ms. Walker's 4th grade classroom. Since I was interested in learning more about students' funds of knowledge, it was important for me to interact with the students as much as possible, without interfering with their learning. From September to October 2006, I was a participant observer once a week for at least two and a half hours per visit. My first observation occurred during the first week of school. The teacher introduced me as someone working on my doctoral degree at the nearby university.

During the first two months, I developed relationships and built rapport with the students and the teacher through observing students during school and helping out with various activities (e.g., having students read out loud to me, helping facilitate group work, working with the students on writing autobiographies). My time in the classroom during these months was limited due to students' preparation for statewide testing.

In November and December, I spent at least two afternoons a week in the classroom. Since I was interested in learning about the students' everyday experiences and their lives outside of school, I talked to the teacher about working with students on autobiographies. She was more than happy to let me work with groups of students on autobiographies, especially because her class was quite large and there were many students who were loud and gregarious. She was looking for ways to manage the class and had planned to start centers. During the centers time, she intended to ask the reading specialist to come in to work with a group of students. If I worked with another group of students and she worked with rest, she hoped to alleviate some of the classroom management issues. So she incorporated the autobiographies into the centers rotation. I

worked with groups of students during the centers time twice a week. In addition to writing autobiographies, I also gave each student a disposable camera to take pictures of things and people who were important parts of their lives. I worked with the students on creating PowerPoint presentations that incorporated content from their written autobiographies and pictures they had taken.

From January until the end of the school year, I spent at least three, three-hour blocks of time in the classroom. In April, the class went on a week-long field trip to a local nature center. I participated in the entire field trip, helped lead nature observations, and taught an "expert" lesson. On the participant observer continuum, I was more on the participant end (Bogdan & Biklen, 1992). Because I was interested in learning what students know about the material world from daily family, community, and peer practices, I felt this was best achieved by interacting with students and finding opportunities to ask them about these practices during classroom activities and informal conversations. In addition to regular school activities (those that take place during regular school hours), I was also a participant observer in after-school activities twice a week. Starting in February, I tutored one of my focus students for approximate two hours, once a week in his home. I also conducted a book club with two girls in the class once a week. [10]

The students often viewed me as another authority figure in the classroom. This identity was created in a few ways. First, I was an adult. By default, this positioned me as an authority figure. They also knew that I attended the local university and had been a science teacher. The teacher also positioned me as an authority figure in the class. When

[10] I asked one of my focus students if she wanted to hang out and what she would like to do. She came up with the idea of a book club and her friend, a classmate, asked if she could be part of it too.

the teacher wanted to check students' work before they could move on to another step in an activity, she would tell the students to have either her or me check their work over. I would also work with groups and individual students on various projects and students often asked me for help with their work. Furthermore, Ms. Walker would occasionally ask for my advice or knowledge during class lessons. In additional to helping out with activities, I would sometimes help with behavioral issues and/or help students resolve social issues.

Data generation[11]

In this section, I will describe the data I generated, both inside and outside of Walden school, throughout my year-long participation in Ms. Walker's fourth grade class.

Field notes

I rarely took field notes while I was observing and interacting with students because I was usually an active participant in activities. I wrote field notes immediately after or at least on the same day as an observation. A few times when I was unable to complete field notes on the same day as an observation, I completed the field notes the following day. Field notes were written about in-school activities, after school activities, and evening activities (e.g., Thanksgiving Dinner, Science Theme Night).

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[11] See Table 1 for the data collection schedule.

Audio

Starting in November, I audio-recorded interactions with students during the school day. I wore a digital audio-recorder throughout the day, with which I recorded informal conversations I had with the teacher and students in between classroom lessons and more formal interactions that occurred during lessons. For the most part, I did not record after school activities because these activities involved students who were in other classes throughout the school; whom I did not have permission to audio-record.[12] In addition to audio-recording informal interactions with students, I audio-recorded semi-structured interviews with students, book club meetings, and times when I tutored one of my focus students. I also audio-recorded some informal conversations with parents and the teacher as well as curriculum planning time with the teacher.

Video

I was not researching student learning of a particular curriculum, so I did not plan specific lessons to videotape. I occasionally recorded science activities when I thought they may be provide opportunities for me to investigate how students and the teacher drew on students' funds of knowledge related to life science concepts and when there was enough advance warning to set up. For example, we planned an edible plant activity where students and the teachers brought in various edible parts of the plant. Students were able to try the various parts of the plants and the teacher talked about them.

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[12] There were one or two instances when only students from the 4th grade class I was studying participated in an after school activity. In these cases, I did audio-record the activity.

Because the teacher and I planned this day and the time of these activities in advance, I was able to video-record it. There were other times that may have proved valuable to have video, but I was unable to video because of timing (i.e., a lesson was moved around to fit the day's schedule and I did not have immediate access to a video camera). Furthermore, I did not know ahead of time when something would be provide insight into my research questions and due to limited resources, it did not make sense to try to videotape every science lesson.

Student artifacts

In order to learn more about the students' families and their lives outside of school, I helped students write autobiographies. As part of this project, each student received a disposable camera that she/he used to take pictures of her/his life outside of school. These pictures were digitized and used to create PowerPoint autobiographies. I also collected copies of student work such as their science journals, creative writing, and homework assignments.

School artifacts

I occasionally collected copies of the weekly letter the principal wrote to students' families and other notes sent home. I also collected articles written in the local newspaper about the school and the monthly, student-written, school newspaper.

Table 1

Data collection schedule

	2006				2007					
Activity	**September**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**
Observations of class time	Once a week; ~2 1/2 hours		Twice a week; at least 2 1/2 hours per visit		Three times a week; at least 2 1/2 hours per visit			23-27th weeklong field trip to Wood Nature Center	Three times a week; at least 2 1/2 hours per visit (last day of school June 8th)	
After school activities			Newspaper once a week; 1 1/2 hours							
			iMovie once a week; 1 1/2 hours							
Book club						Once a week; ~40 minutes			Once a week; ~40 minutes	
Tutoring						Once a week; 1 1/2 to 2 hours				
Various family school activities			Thanksgiving Feast Evening		Magnet School Fair	Family Valentine's Day Night		Science Theme Night	Y.A.C. Grant Awards Night	
Semi-formal and/or informal interviews with students, teacher, and parents	Various times for varying amounts of time throughout school year									

Data Analysis

> Rather, statable patterns and themes—assertions that make generalizations about actions and beliefs that were observed—must be searched for repeatedly within the total data corpus, in a process of progressive problem-solving. (Erickson, 2004a, p. 496)

Initial analysis

I went through several stages and frameworks as I analyzed the data. I started my initial analysis by attempting to determine what funds of knowledge the students had access to, how students acquired these funds of knowledge, how the students used them in the classroom, and how the teacher drew on them during classroom activities. As I collected data and roughly transcribed some of the audio-recordings, I looked for themes that students commonly discussed related to the material world (Emerson, Fretz, & Shaw, 1995). I noticed that students had many experiences related to animals, plants, and health issues in many different communities of practice (e.g., family, school, media). This led me to ask my focus students more about these topics in informal conversations and formal interviews - particularly their practices relating to animals and plants. Because the funds of knowledge scholarship focuses on practices, I attempted to elicit the types of practices students' knowledge was embedded in, such as caring for pets at home or at school (Gonzalez, Moll, & Amanti, 2005; E. Moje et al., 2004).

My initial data analysis was guided by the work of Moje and her colleagues (2004) and Calabrese Barton and Tan (in preparation) that examined students' funds of

knowledge and categorized them by communities of practice. Based on this work, I looked for students' funds of knowledge and attempted to categorize them according to family, community, peer, and popular culture communities of practice. In particular, I proposed looking for the following:

- Where do students' funds of knowledge originate (i.e., family, community, labor practices, social practices); what communities of practice do students participate in?
- What types of funds of knowledge do students hold (i.e., plants, animals, health)?
- What are students' understandings of their funds of knowledge (e.g., what do students know about plants, animals, health); how do students make meaning of their practices?
- When, where, and how are these funds of knowledge displayed (i.e., how these funds of knowledge shape a discussion, ways of thinking about a particular topic)?
- When, where and how does the teacher draw on these funds of knowledge?
- What types of connections do students make between their funds of knowledge and school learning?

I used constant comparative analysis to look for practices students had with the material world across repeated and multiple contexts and communities of practice (Glaser & Strauss, 1965 as cited in LeCompte & Schensul, 1999). I looked for experiences that were direct and embedded in practices (i.e., touching a tree) or indirect experiences (i.e., hearing about experiences of family members, peers, or media).

As I continued to analyze my data, my analysis was shaped by what I discovered.

As I mentioned previously, when generating data I attempted to roughly transcribe as much of the audio data as possible. Most of the rest of the data was roughly transcribed at the end of the data generation period. I created an index for my audio, video, and photographic data using an excel spreadsheet. The index contained the date and time length of each audio file. It also included a general description of the content of the data file. One audio file often contained 2 hours of audio; one file might include a math lesson, science lesson and interview with a focus student. Therefore, I also had columns that further denoted if the recording contained audio of science class, book club, tutoring, and interviews. I also had a column for noting if any of my focus students said anything I found interesting during that time, if the file included talk with parents, and columns for if I also had video and photos of the event.

As I sorted through the data, I coded when my focus students participated in a particular activity/time such as a science lesson, tutoring session, book club, informal conversation, etc. (Bogdan & Biklen, 1992). I also coded for activities where I felt like students were bringing up their funds of knowledge. I originally envisioned having case studies of focus students where I traced students' funds of knowledge from outside of school to their practices inside of school. In my analysis, I found that it was difficult to trace students across the activities. Students sometimes participated more in one activity than another. I also found that it was difficult to determine the community of practice that was associated with students' funds of knowledge. Funds of knowledge often spanned communities of practice. Furthermore, when a student brought up his/her knowledge in a class activity, I often could not tell the source of the knowledge. Thus, I chose to focus on activities and how students were drawing on (or not drawing on) their

funds of knowledge. I looked at activities that had "intrinsic interest" and were "occasions of theoretical interests" (Erickson & Shultz, 1981) and fully transcribed these activities. Then I wrote vignettes. As I wrote vignettes, themes or codes emerged for the activities. I performed deeper analysis on one activity. As I did the analysis on one activity, I thought about how the themes applied to other activities.

Norms

As I continued my analysis, I was influenced by Cobb and his colleagues' work on norms (Cobb, Wood, Yackel, & McNeal, 1992; McClain & Cobb, 2001; Yackel & Cobb, 1996). I believe that norms are created by and embedded in practices. In other words, repeated practices or patterns of behaviors create norms that are acceptable in a particular context. In addition, one's practices and behaviors are guided by norms. I found norms to be a useful analytic concept because, as Carol Lee stated:

> Norms for talk tell which members who can talk, when, and about what. Routine activities show members the interactions that are valued, the problems that are worth addressing, and the useful ways of attacking these worthwhile problems." (2001, p. 115)

In my data, I saw three major threads running through the activities: the norms for the science that was accepted in the activity, the reasoning about the science or socioscientific norms, and the social interactions amongst participants or social norms. I analyzed how these three threads played out in terms of the opportunities for learning they provided for students. However, as I continued my analysis, my framework shifted yet again.

Cultural Historical Activity Theory

Since I was interested in examining activities and how they provided varying opportunities for students to draw on their funds of knowledge, I also investigated cultural historical activity theory. Gutierrez (2002) talked about the affordances of activity theory. She stated:

> Of significance, this particular theoretical standpoint provides a methodological approach for discerning the hybridity and heterogeneity inherent in cultural activity, cultural artifacts, and their participants... (p. 314)

Lee and Majors (2003) also highlighted the importance of cultural historical activity theory. They said:

> It is largely through discourse that norms for participation are constituted within an activity setting. Talk is one among a number of resources available to participants as they negotiate emergent goals. The norms for talk, artifacts, the goals and social/cognitive resources of participants, the roles assumed, together interact to constitute the activity. (p. 51)

They also discussed the importance of analyzing discourse to investigate how the parts of the activity interact. There are six aspects of cultural historical activity theory: subject, object, mediating artifacts, rules, communities, and roles (Figure 1).

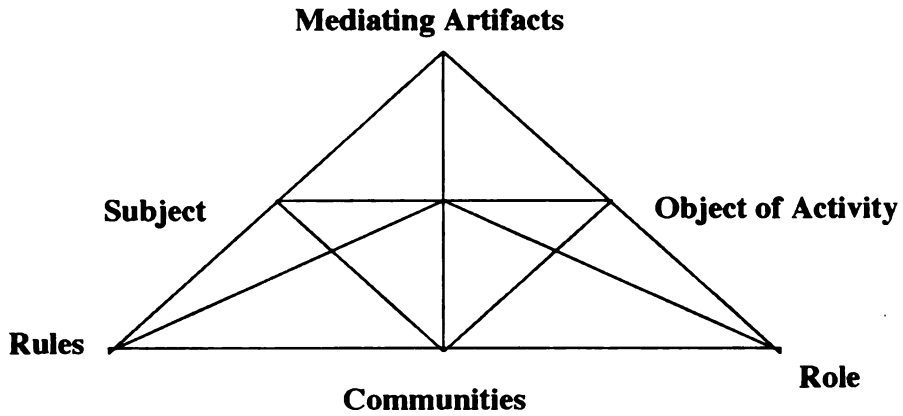

Figure 1. Cultural historical activity theory model as seen in Cole (1996) and Lee and Major (2003)

These aspects interact to constitute an activity system that provides opportunities for students learn. Since learning from a sociocultural perspective is about entering a complex community, cultural historical activity theory is one model used to represent and study the complexity of the factors that play a role in an activity. In my analysis, I draw from aspects of cultural historical activity that I find useful to explain my data. Similar to Lee and Major, I use discourse analysis to investigate the interactions amongst aspects of an activity. In the next two sections, I discuss an analysis framework that implicitly uses aspects of cultural historical activity theory and how I draw on it in my analysis.

Enyedy and Goldberg's framework for analysis

While Enyedy and Goldberg (2004) did not explicitly draw on cultural historical activity theory, much of their analysis seems to align with aspects of it. For example, in their study they examine the *object of activity*, which is one aspect of cultural historical activity theory. They also use what they call the participation framework, which includes aspects of *rules* and *division of labor*. They address the *subject* in their analysis as they examine how the teacher positions herself in relation to the students.

Although Enyedy and Goldberg do not explicitly use cultural historical activity theory in their study, they use aspects of it in their analysis in order to elucidate how discourse and classroom interactions shape a classroom learning community. In their work, they draw on the concept of communities of practice to conceptualize learning. The concept of communities of practice focuses on learning from and through the social interactions of a community, rather than an individual's learning. It draws on notions of zone of proximal development (Vygotsky, 1978) and legitimate peripheral participation (Lave & Wenger, 1991). As one enters into and become part of a community of practice, she/he is apprenticed into the community. In the case of classroom activities, the teacher traditionally serves the role as expert and authority figure. The teacher typically chooses the activity and the object of the activity. Enyedy and Goldberg assert that the interactions between the teacher and students are one of the most important aspects of teaching and learning. They state:

> From this perspective teachers can be seen to be continually engaged in a form of language socialization, which is directed at bringing children into school-based intellectual practices that are intimately connected to how a student comes to

understand the scientific content of the lesson. Therefore, analysis of activity systems and discourse are critical for understanding how classrooms are constructed and then shape students' access to learning." (p. 909)

It is important to note that while both the concepts of zone of proximal development and legitimate peripheral participation assign an importance to learning with the help of a more experienced learner, they do not discount what one learns from peers. What and how one learns from peers can be equally valuable when one is entering a community of practice.

Enyedy and Goldberg draw on what they view as two core concepts of communities of practice to frame their research. First, they examine "...the shared object of the activity that motivates individuals to engage in coordinated activity together and that defines the community" (p. 907). Second, they study the rules, roles and relationships (which they sometimes call rules, roles, divisions of labor and unequal power relations). Enyedy and Goldberg do not focus on the quality of the science content of the teacher's talk. They instead focus on the teacher's interactions with students in order to see how these interactions create affordances and constraints for student opportunities to learn.

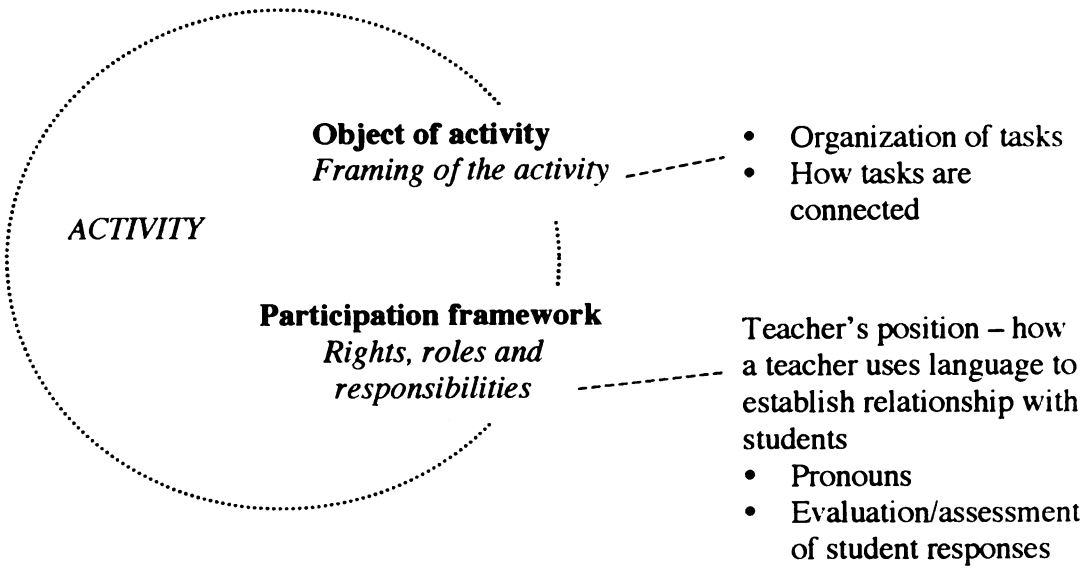

Figure 2. Enyedy and Goldberg's framework for activity analysis[13]

Object of Activity

In order to study the object of the activity, Enyedy and Goldberg examine the organization of the tasks and how the tasks are connected. For example, they describe how one teacher frames an activity within the context of other related classroom science activities. They show how the teacher clearly states the activity objective and connects tasks within the activity. The teacher's actions and interactions with the students demonstrate the object of the activity.

[13] Enyedy and Goldberg did not have a diagram depicting their analytical framework. I created this diagram based on my understanding of their work. I take full responsibility for any misrepresentation of their work.

Participation framework: Rights, Roles and Responsibilities

In the second concept, they look at how teachers position themselves within the classroom community. They draw on the notion of participation frameworks. Participation frameworks consist of the rules that guide who can talk, when one can talk, what one can talk about, and to whom. Enyedy and Goldberg assert:

> People use their understanding of what type of activity they are doing and what their role is to limit what they do and say – what people do and say has direct implications for the meaning that they take away from their experience. (p. 910)

In their analysis, Enyedy and Goldberg focus on how the teacher uses language to establish relationships with the students. They examine two aspects: 1) the teacher's use of pronouns, and 2) the teacher's "assessment" of student talk.

Enyedy and Goldberg investigate whether the teacher positions herself as a co-inquirer or in a position of authority. In order to investigate this, they examine the pronouns that the teachers use. Pronouns can serve inclusive or exclusive purposes. For example, the pronoun "we" is typically considered an inclusive pronoun to mean something to the effect of "together we will..." Other examples of inclusive pronouns are "us" and "our". Exclusive pronouns, such as "I", "she", "you", and "they" serve to distance the speaker from the person or people the speaker is referencing. Enyedy and Goldberg recognize that there are instances when certain pronouns may be more appropriate for use than others, such as storytelling. But they argue that examining a speaker's use of inclusive and exclusive pronouns can signify how a speaker positions herself or himself in relation to other participants in a community.

The study of pronouns can show how a teacher establishes a sense of community, or gives directions – which can illustrate the division of labor in a community. For example, when a teacher says, "We need to consider how we're going to..." or "we decided to...", the use of inclusive pronouns shows that the community as a whole makes decisions. This can serve to distribute power amongst the community. When a teacher says "you need to...", this serves to tell the recipient her/his roles and the steps she/he must take next in the activity in order to complete a task.

Enyedy and Goldberg also examine how a teacher responds to student talk. They talk about this in terms of teacher "assessments". For example, does the teacher build on student ideas or respond in a positive or negative manner? Teacher assessments can serve to create or restrict further learning opportunities. Wells and Arauz (2006) similarly talk about the importance of a teacher's "assessment" of students. They focus on the Evaluation or Feedback part of the Initiation, Response, Evaluation (IRE) triadic dialogue. They emphasize the importance of the feedback in creating dialogic talk. In their study, Wells and Arauz found that, "What matters for the quality of interaction, it seems, is not so much how the sequence starts, but how it develops, and this, as we have argued, depends critically on the teacher's choice of roles and on how he or she utilizes the follow-up move." (p. 421). When a teacher takes up what a student says and expands on it, it can serve to validate the student's response even if the response is "incorrect". They found that when teachers provided feedback that extended a student's response, it resulted in a collaborative learning process.

Tannen (1989) talks about how repetition, such as repeating, restating or revoicing a student's response can show acceptance of his/her utterance. Similarly,

Cazden (2001) discusses the importance of extending a child's response, versus simply correcting. Extending serves to validate a child's response, idea, or opinion, and also scaffolds her/his way of thinking about something. Restating or revoicing can serve to "give it [speaker's utterance] a bigger voice" (p. 90). Thus, how a teacher responds to a student plays an important role in the how the teacher positions herself in relation to the students, what students learn, and how students learn.

Extending Enyedy and Goldberg's framework

I found Enyedy and Goldberg's framework useful for my own analysis. As I delved deeper into analysis of activities in my study, I noticed many of the same themes. I detected differences in the how the students participated in an activity and the opportunities for learning the activity afforded students varied greatly depending on the activity and how the teacher framed it. I also saw differences in how the teacher positioned the students; the power and authority during an activity was distributed differently. I saw patterns in how the teacher and I, as another teacher figure, used pronouns and assessed or provided feedback to students.

Object of the activity

I use a modified form of Enyedy and Goldberg's framework (Figure 3) to frame my study. I employ their concept of *object of activity* to examine the task that the teacher sets and how she frames the task of the activity. In other words, what are the task parameters the students need to work within to complete the task. I also discuss how the

task and its parameters are reinforced and negotiated by the teacher, student and me throughout the activity.

Participation Framework

In this study, I label *rights, roles and responsibilities* as *positioning and power*. I investigate how the teacher positions herself in relation to the students as co-inquirer, facilitator, or in a position of authority. I extend rights, roles and responsibilities to also describe how the teacher positions the students as knowledgeable designers or passive receivers, and how the students, teacher and I negotiate these roles and what it means in terms of how we engage in the task. Similar to Enyedy and Goldberg, I recognize that positions and roles within a community are dynamic. I focus on classroom interactions, specifically the ways the teacher **and students** use their classroom discourse to form, maintain, and change the community of their classroom.

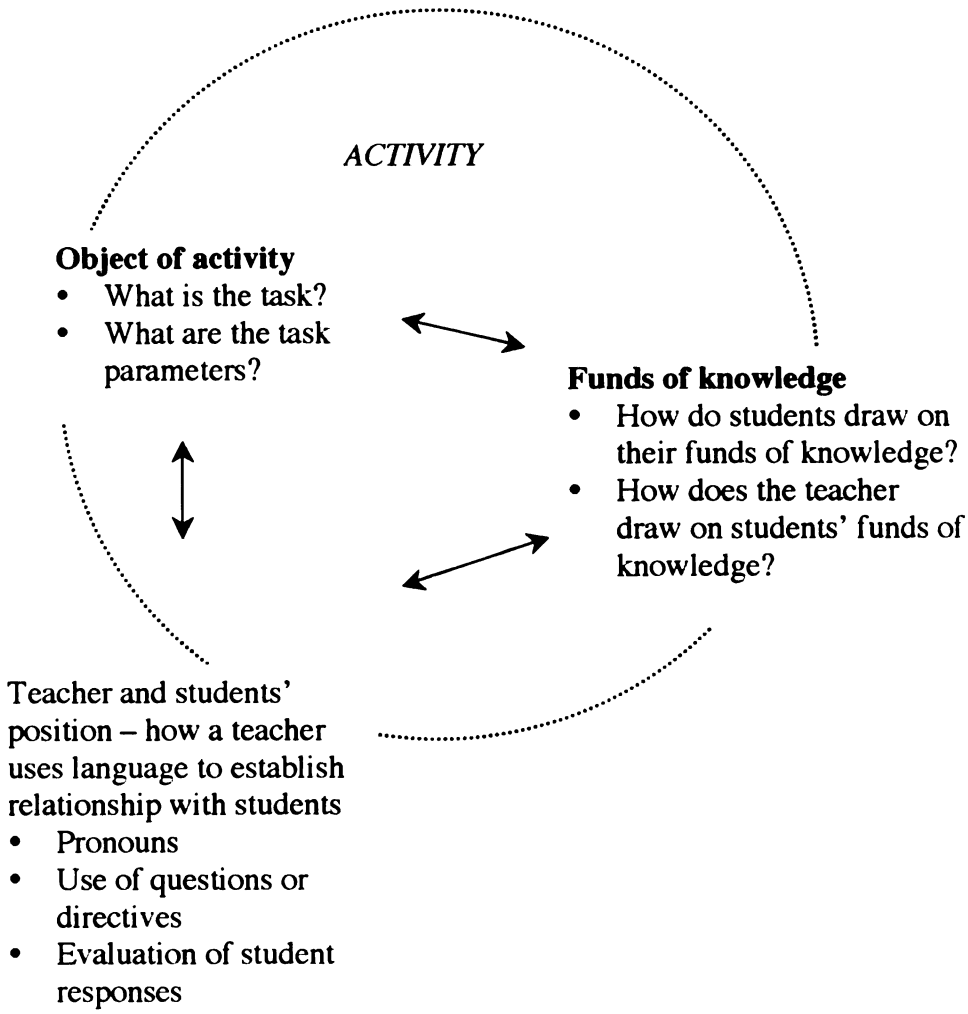

Figure 3. Tsurusaki's framework for analysis

Funds of Knowledge and Hybrid Spaces

Furthermore, I analyze the object of activity and participation frameworks to gain insight into my research questions:

- How do students draw on their funds of knowledge in science class (an activity)?

- How does the teacher draw on students funds of knowledge in science class (an activity)?

In this study, I define funds of knowledge very broadly. I acknowledge that funds of knowledge are embedded in practices. While it is not always clear where these funds of knowledge come from, I use the term to signify the "knowledge" that students draw on (outside of the knowledge the teacher provides) as they navigate an activity. I retain the label "funds of knowledge" to recognize that knowledge is embedded in practices that are social and historical in nature and to emphasize the importance of the funds of knowledge that the students bring to an activity. I examine how the object of the activity and participation framework can create (or do not create) spaces for students to draw on their funds of knowledge and create hybrid spaces. I also investigate how students leverage (or do not leverage) their funds of knowledge to negotiate or co-opt the task. In other words, in my framework I recognize that the object of the activity, the participation framework and funds of knowledge influence each other and whether or not hybrid spaces are created.

Overview of three activities

Rationale for activities analyzed

As I sorted through my data, I noticed that there were interesting differences between two model activities, what I call the bird activity and the bee activity. The students and teacher interacted very differently in the two activities even though they were building animal models in both. In the bird activity, the students appeared to be drawing on their funds of knowledge but I did not see this happening in the bee model. I was interested in examining how and why the activities provided different learning opportunities. I chose the third activity, the pond activity, because similar to the bird activity, it was an activity where students appeared to be drawing on their funds of knowledge to work on the task. I also found it interesting because it was a more informal activity and the conversation flowed more freely than in more traditional classroom activities. The students built on each other's ideas, asked each other questions, and supported each other's ideas.

All three activities took place in the spring of 2007. During the spring, the students completed a plant unit and an ecosystems unit. As part of the plant unit, the students grew hydroponics plants, Wisconsin Fast Plants, and plants from seeds grown in soil. During the ecosystems unit, the students learned about the desert, ocean, arctic region, and rainforest, as well as characteristics of ecosystems such as its climate and the types of animals and plants that live there. They also learned about the interconnectedness of life, food chains, and food webs.

The bird activity

The bird activity took place on May 16th near the latter part of the ecosystems unit. The students were asked to create their own bird that they designed out of construction paper. As part of the task, the students were supposed to consider the form and function of a bird's adaptations and how the adaptations enabled it to survive in its ecosystem.

The bee model

The bee model activity took place on March 14th during the latter part of the plant unit. The students learned about how bees help pollinate flowers. In this activity, the students were asked to create an accurate model of a bee. They were provided with templates of the bee parts. They colored, cut out, and glued the parts together to make their bee model.

The pond discussion activity

As previously mentioned, I included the third activity because the students seemed to be drawing on their funds of knowledge to complete the task. The activity took place on March 21st. It was a less formally structured activity. I sat down with a group of four students to talk about what we needed to do to build a pond out in front of the school. We discussed our resources – time, money, and physical materials – and how we wanted to design the pond area.

The purpose of my analysis was not to critique the teacher, myself, or our teaching. The purpose was to examine activities and how the object of the task and participation framework for an activity worked to create different learning opportunities for the students. In particular, I was interested in investigating when and how students and teachers drew on students' funds of knowledge and created hybrid spaces. In other words, what types objects of activity and participation frameworks and the reciprocal relationship between the two aided or inhibited the students' ability to make connections between what they are learning in school science and their funds of knowledge and Discourses outside of school and merge them with school science to create a deeper understanding of science.

CHAPTER 3

Bird Activity

Unit context

The activity analyzed in this chapter came during the final unit of the school year. The final unit, which began in April, was about ecosystems, or interdependence of plants and animals. According to the district pacing guide, by the end of the unit the students should be able to:

- Identify the needs of animals (air, water and space in a habitat)
- Compare and contrast the needs of plants and animals
- Describe plants as needing light for energy
- Compare and contrast the way plants and animals get energy
- Compare and contrast the environmental needs of plants and animals
- Design and ecosystem for plants and animals to live together
- Describe how human can have a positive effect on the environment (conserving non-renewable resources, protecting wetlands, etc.)
- Describe how humans have a negative effective on the environment (over use of non-renewable resources, polluting land, air and water)
- Explain how fossils are evidence of earth long ago (ancient life forms)
- Explain how fossils are evidence of change in plants and animals (adaptation)

Ms. Walker typically scheduled 4 days a week of science. However, she taught more or less science lessons depending on factors such as school assemblies, field trips, or spending more time on another subject (i.e., when an activity took longer than expected, which took away from the amount of time for other lessons).

I missed the first two weeks of the unit due to travel and other obligations. On my first day back, April 18th, Ms. Walker and I discussed what the students had learned while I was gone (from audio data 070418d). The following information about lessons from the first two weeks came from a conversation I had with Ms. Walker when I returned and photos of work on chart paper the class completed while I was gone. Sometimes when Ms. Walker conducted a class discussion, she would write student questions and ideas, or information such as definitions that she thought were important on a piece of chart paper.

Ms. Walker told me that she started the ecosystems unit with a class discussion of human interactions with nature (Figure 4). She wanted to figure out what things student came into contact with. She drew the face of a human on a sheet of chart paper and the students added pictures of the things that they interacted with on the paper. The students drew pictures of squirrels, worms, grass, bushes, dogs, trees, flowers, and bees.

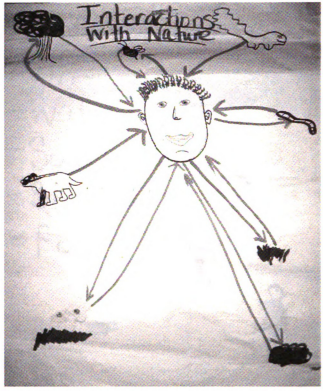

Figure 4. Students' work: Interactions with nature

Ms. Walker told me that the class attempted to draw arrows between the human and the things they interacted with (Figure 4). For example, she told the students that she interacted with squirrels because squirrels eat the nuts around her house, but the squirrels do not really provide her (humans) with anything. Thus, the arrow between the squirrel in the top right hand side of the picture only goes in one direction. Ms. Walker told me that the students said that they interacted with worms because they feed worms, like when they put food in the worm bin at school. They also said that they interacted with bushes because they ate fruit off bushes.

Ms. Walker told me that the students also watched a movie about different ecosystems and then identified the things that all living things need (Figure 5).

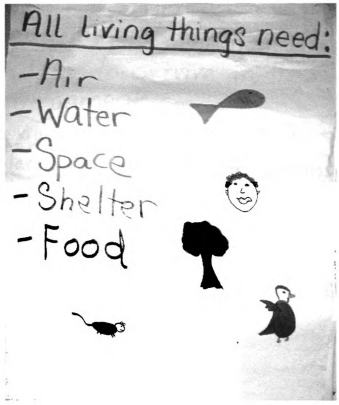

Figure 5. Students' work: Things that all living things need

Ms. Walker also talked with the students about adaptations and a few examples of animal and plant adaptations (Figure 6).

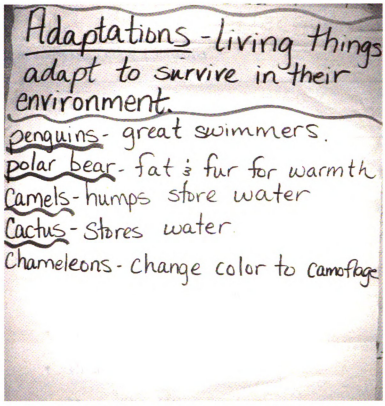

Figure 6. Students' work: Adaptations

Ms. Walker also had the students read trade books about different ecosystems: desert, rainforest, water and artic region. The class discussed the things they learned about the ecosystems and Ms. Walker wrote down student comments on large sheets of chart paper (Table 2). In addition, she had them do what she called, FQRs (Facts, Questions, Responses) to guide their reading. Ms. Walker asked groups of students who looked at a similar trade book (e.g. Desert ecosystem trade book) to come up with three facts and three questions they had from reading their book. They were also instructed to come up with three responses to group members' questions.

Table 2

Data gathered from ecosystem class discussion[14]

Ecosystem	Student knowledge or comments
Desert	• Very hot, or very cold
	• Hardly any plants
	• Very dry
	• Stored water, dig for water
	• Hide in holes
	• Hunt coyotes, snake, crickets
	• Hunt at night if hot
	• Be careful of scorpions
Rainforest	• Animals everywhere
	• Very wet
	• Plants growing everywhere
	• Eat fruits & plants & nuts
	• Understory, emergent, canopy
	• Hot – lots of bugs
	• Squirrel eating nuts on Kapok tree
	• Monkeys
	• Eat rodents

[14] This data was generated from the information Ms. Walker wrote on chart paper during discussion of what students learned about ecosystems.

Table 2 continued

Rainforest continued	• Protect animals & trees • Snakes
Water	• Find shelter under a rock or in the sand • Eat small fish • I would want to be a shark • I wouldn't know how to eat • It would be cold deep down. • I would need gills or I would have to come up for air. • Anything bigger would be a predator
Artic Region	• Need a lot of clothes, fur & far. • Huddle up for warmth • Eat fish • Make igloo • A lot of wind • Northern lights

Ms. Walker had the students write fictional stories, where she asked them to imagine if they lived in one of the ecosystems discussed in class (e.g., water). She also read picture books, *The Great Kapok Tree* (Cherry, 1998) and *The Lorax* (Dr. Seuss, 1971) to the class. Both books emphasize the interconnectedness of organisms and conservation of ecosystems.

Weeklong field trip to Wood Nature Center

From Monday, April 23rd to Friday, April 27th, the class spent time at a local nature center. They left the school at around 9 am everyday to travel to the nature center and left the nature center by 1:45 pm to travel back to the school. I accompanied the students on the field trip the entire week. The following section contains narrative descriptions of each day spent at the nature center.

Monday, April 23, 2007

The first day, Ms. Walker passed out journals to each student before we left the school. We boarded the school bus and arrived at the nature center approximately 15 minutes later. When we arrived, we disembarked the bus and went inside a big white barn that was used as a classroom. Ms. Walker told the class that a naturalist from the nature center would be conducing a few of the lessons with the students throughout the week. In fact, the naturalist would be taking the class on a walk of the area that morning. To help the students prepare for the nature walk, Ms. Walker asked the students a rhetorical question; she asked them to think about what they thought they would see on our walk. Then she read the book, *Lost in the woods: A photographic fantasy* (Sams & Stoick, 2004). The book was about a young deer finding his way in the woods. The deer encountered a frog, cardinal, turtle, and other creatures along the way. Ms. Walker told the students that a young baby deer is a fawn, a mother is a doe, and a father is a buck.

Many of the students knew this; they chimed in when she said each name. Trevor mentioned that bucks lose their horns.

After the story, the class went outside for the nature walk. The naturalist took us on one of the trails. During our walk, we first stopped at the prairie/grassland area. The staff at Wood Nature Center had just performed a controlled burn. The naturalist explained the purpose of a controlled burn – to prevent succession. In other words, the staff at the nature center did not want the prairie to turn into a forest. They wanted to retain the different habitats at the nature center so visitors could experience the prairie and different types of forests. On our walk from the prairie and through the pine forest, we saw some animal fur lying on the trail and the naturalist said that it was probably rabbit fur. Then we walked through the pine forest and by the edge of a hardwood forest. The naturalist pointed out the hardwood forest and mentioned two types of trees that grow in hardwood forests - oaks and maples. The naturalist showed us a gall on one of the leaves of a hardwood tree and talked about how it was created by an insect when it poked a hole in the leaf and laid its eggs inside. We then walked to a pond area that was located in the middle of the forests where we saw a turtle, some geese, and a frog. As we continued along the trail, we came to a river. We briefly walked along the river and then back through the woods. We saw some orange slices hanging from trees in this section of the woods. The naturalist told the students that another school group had hung them for birds, particularly orioles. Finally, we arrived back at the white barn.

When we got back to the classroom inside of the white barn, Ms. Walker had the students close their eyes and picture themselves walking on the trail again. Then she asked them to draw a map of the area and the things they had seen in their journals. The

students made a map, then paired with a partner to include more details on their maps, and finally switched partners to try to provide as detailed a map as possible. Students mentioned various animals they had seen and the different habitats they walked through.

After the map exercise, the students had lunch. After lunch, Ms. Walker introduced the students to levels of observations. She told the students that we were going to go outside to make observations in one of the five areas the students had seen on the nature walk: the prairie, the pine forest, the hardwood forest, the pond, or the river. During the observation time, she first wanted students to write down their initial impressions. The students were asked to write down what they felt or saw when they first entered the habitat. Then, they were supposed to make ground level observations (observations of what they saw on the ground), eye level observations (observations of what they saw at their eye level), overhead observations (observations of what they saw overhead, or above their eye level) and landscape observations (observations of the entire scene). After explaining the instructions, Ms. Walker divided the class up into three groups. Each group went to a different area for observations and rotated through the areas throughout the week. Each group walked to their observations area, where the students were supposed to sit quietly and record their observations in their journals. As soon as we got back from our observations, we had to get on the bus for the ride back to school. We did not have a chance to talk about our observations.

After we arrived back at school and returned to the classroom, Ms. Walker asked the students to journal about their experience at Wood Nature Center and what they expected for the rest of the week. Then she did a Wonder Wall with them. She gave each student two post-it notes and had them write down two questions or wonders they

had. Then each student shared. The students asked questions like "How deep is the pond?" and "Are there any poisonous flowers?" For the last activity of the day, Ms. Walker talked to the students about different shapes such as triangles and rectangles. She had them draw triangles – equilateral, isosceles, and scalene and rectangles - square, rectangle, quadrilateral, parallelogram, and a pentagon, hexagon, octagon, and circle in their journals. She explained that the students would use look for these shapes in nature the next day during their observations.

Tuesday, April 24, 2007

On Tuesday when we arrived at Wood Nature Center, Ms. Walker showed the students some examples of what she considered exemplar student journal entries. The entries were from the previous afternoon's observations: initial impressions, ground observations, eye level observations, overhead observations, and landscape observations. Ms. Walker talked about how the exemplars contained good descriptions and pictures. After this, Ms. Walker read the book, *ABC's Naturally: A child's guide to the alphabet through nature* (Diebel & Kalscheur, 2003). The book showed photographs of different letters of the alphabet in nature and had poems that went with the letters. After Ms. Walker read the book, she told the students that during today's observations the students were to look for shapes in nature similar to the shapes they drew in their journals in the previous afternoon - triangles and rectangles - and alphabet shapes like the ones they saw in the picture book Ms. Walker read. Then the class divided up into groups and went to their assigned areas to conduct observations.

When the students came back from their observations, they played "Oh Deer!", an activity from *Project Wild* (Project Wild, 2001). The "Oh Deer!" activity taught the students about three resources essential for animal survival: food, water and shelter. It also demonstrated how the resources played a role in the carrying capacity of a habitat. The students were divided into two groups. One group represented the deer and the other group represented the resources. The two groups formed parallel lines about 20 yards apart, with their backs facing each other. Each deer was looking for one of the resources necessary for survival. Each individual deer chose which resource he or she was looking for and indicated this by either placing his/her hooves (hands) over its stomach to represent food, hooves over its mouth to represent water, or hooves over its head to represent shelter. The "resources" also chose which resource he or she wanted to be and represented that resource by using the same hand gestures as the deer. When the teacher shouted, "Oh Deer!" the two groups turned around to face each other. The deer ran toward the resource that he or she was seeking. Deer who did not find their resource died. In the next round, the deer that died became resources. This process was repeated for multiple rounds. The class recorded the number of deer that existed in each round and graphed the flux in population over the rounds, which represented years. The students completed a few rounds of the activity during this time and graphed the results later in the classroom at the end of the day.

In the afternoon, the class divided up into two groups. The naturalist took one group to another building where the interpretive center was located. The upper part of the interpretive center contained taxidermy animals mounted on the walls along with some interpretive information about the nature center such as information about the trails

and the natural history of the area. The lower part of the interpretive center housed live rescued animals - two squirrels and a groundhog - and some fish. The students went into the lower area and looked at the live animals. After the students looked around, the naturalist did an activity with the students. The students built an aquifer and talked about pollution. In order to build their aquifer, the students needed to decide what type of substrate – sand, pebbles, or a mixture of sand and pebbles - to use in their aquifer and the order of the layers of substrate. After the students built their aquifer and discussed its ability to filter pollution, the naturalist talked about how clay was the best substrate to use because it absorbed water so that the water filtered very slowly through it.

The other group stayed with Ms. Walker. Ms. Walker did an Enviroscape activity with the students. The Enviroscape was a portable watershed/nonpoint source model (see http://www.enviroscapes.com/nonpoint-source.html for more information about Enviroscapes). The model included a landscape with a few roads, some houses, a barn, a factory, trees, cars, tractors, cows, and rivers that flowed into a larger body of water. Cocoa was used to represent soil and Kool-Aid was used to represent chemicals. Ms. Walker asked students to put cocoa and Kool-Aid on various parts of the model and then spray water from a spray bottle (which represented water) so the students could see how pollution ended up in the water system.

At the end of the day, Ms. Walker asked the students to journal about their experiences with three activities: the Enviroscape, the aquifer activity with the naturalist, and the "Oh Deer!" activity.

Wednesday, April 25, 2007

In the morning, Ms. Walker had students share "knee to knee". The students sat in two circles – one inside the other. The inside circle of students faced outward and the outside circle of students faced inward so that the students were facing each other. The students were asked to share with the person they were facing in the circle. Ms. Walker had them share three times – one time for each question they were supposed to reflect on in the previous afternoon's journal writing (Enviroscape, Lena's experiment, Oh, Deer). Then the naturalist arrived and the students broke up into two groups for their morning activities. One group went with the naturalist and she took the students on a walk through the woods and talked about producers and consumers. She talked about signs of producers and consumers in the woods. The naturalist's groups did not stay outside for long because it rained steadily that morning. The naturalist then took her group to the upper part of the interpretive center. There, the students saw the taxidermy animals, other artifacts such as pieces of wood, fossils, and rocks and interpretive materials. The students played an echolocation game called "Bats and Moths". For this game, the students stood in a circle. One student was chosen to be a bat and one a moth and both students stood inside the circle. The bat was blind-folded and clapped in order to locate its prey, the moth. Whenever the bat clapped, the moth had to clap in response. The bat attempted to catch the moth, locating the moth through echolocation (the clapping).

The other group went with Ms. Walker. Ms. Walker also talked to the students about producers, consumers, and decomposers. She went over the definitions of the terms and had the students write the definitions down in their journals. She also talked to the students about food webs and did a food web activity with the students. She gave

each student a card with an abiotic or biotic part of the food web. The students were seated in circle. Ms. Walker gave one student a ball of string. That student, holding onto the end of the string, passed the ball onto a student with a biotic or abiotic factor that it interacted with. For example, the student with the sun passed the ball of string to grass because it provided energy for the grass to grow. The grass passed the string onto a deer because the deer ate the grass. At the end, the string formed a visual food web.

After this, Ms. Walker read *On this Spot: An Expedition Back Through Time* (Goodman & Christiansen, 2004). The book took the students on a journey back through time to envision what was like in one particular spot years and years ago and how this changed over time. The class discussed the importance of conserving the land that we have and what we can do to ensure we still have places like Wood Nature Center in the future.

Back at the school, the students read a trade book about ecosystems in partners and took notes in their journals. I missed this portion of the day because I took a student to help her interview students in another class for the school paper.

Thursday, April 26, 2007

Thursday morning, the naturalist came to take a group of students outside to do a pond study. The group walked to the pond and the naturalist gave the students pond scoopers to use to gather things from in and around the pond area. The students placed the things that they gathered into large plastic buckets. The other group stayed with Ms. Walker and did the "Fashion a Fish" activity from *Project Wild Aquatic* (Project Wild, 2000). In this activity, the students learned about fish adaptations and how these

adaptations helped fish survive in their habitats. Ms. Walker first told the students the different types of adaptations of fish: mouth, body shape, coloration and reproduction. For example, she told the students that a fish with sucker-shaped mouth feeds on very small plants and animals. The students were split up into groups and each group was given four cards. Each group had a card that told them a specific type of mouth, body shape, coloration, and reproduction method (e.g., eggs attached to vegetation). The students combined the fish adaptations on their cards to create a fish. The end product was a picture that the students drew of their fish.

After lunch, I did a mini-lesson to show the students about how to use pond field guides. Then the students split up into three groups and looked at the pond water and critters they found that morning. Ms. Walker had set up three hula hoops on separate tables. She put plastic over the hula hoops and poured pond water in each of the mini "ponds". The students used hand lenses to examine the critters. I also helped students look at specimen under a microscope. The students used the pond field guides to help them identify the things they saw in the water. This was the last activity we did before we left to head back to school. When we arrived back at the school, the students spent the rest of the day watching the animated movie, *Fern Gully*. I took some students to repot some plants that the students were growing from seeds from their plant unit so we could take them to Wood Nature Center the next day to plant.

Friday, April 27, 2007

We did the outside observations right after we arrived at Wood Nature Center on Friday morning. Quite a few parents volunteered to chaperone that day, so the parents

helped take groups on their observations. While Ms. Walker explained the type of observations she wanted students to do, I looked for maps. I gave each parent chaperone a map and explained where they were supposed to go. Thus, I did not hear the instructions for the day's observations.

After the morning observations, Ms. Walker took a group to go bird watching and I did the activity, "What's for Dinner" (Project Wild, 2001) with the other group. In this activity, the students talked about what they ate for dinner and attempted to trace the food back to the producers. In other words, they traced the route from table to farm. The goal was for the students to recognize that we depend on producers directly and indirectly for food. For example, when we eat beef, the beef came from a cow that ate corn or grass, which are producers.

After lunch, the naturalist took a group of students outside to plant the plants that we brought from school in an area beside the visitor center. Ms. Walker conducted a summary discussion with the other group. She talked with the students about what they enjoyed during their experiences at Wood Nature Center and what they learned. When students got back to school, the students watched the rest of the movie, *Fern Gully*.

April 30th to May 11th

During the next two weeks, from April 30th to May 11th, the students did very little science. Part of this was because Ms. Walker was at a conference for magnet schools for an entire week. Also, Ms. Walker spent some time trying to catch up on some of the math that students did not do while they spent the week at Wood Nature Center. The bird activity analyzed in this chapter was the first science activity that I witnessed

that took place after the field trip to Wood Nature Center. In the bird activity, the students, in partners, created a new species of bird. They had to consider the form and function of their bird's adaptations in their design and how their bird's adaptations helped it survive in its habitat. A more detailed description of the bird activity will be provided at the end of the unit narrative. After the bird activity, the remainder of the interdependence of animals and plants unit and school year was spend outside pulling up weeds from the pond area, digging a whole for the pond, installing the pond, and planting plants in the area around the pond. To the best of my knowledge, the class did not have more discussion of ecosystems and form and function. The students did do some book work about ecosystems. They looked at trade books and answered questions on a worksheet, but I did not collect the books or worksheets as data. Furthermore, since the students were doing this work as individuals, I do not have audio of this because they worked silently. There was not a class discussion about the student responses to the worksheet.

Activity Description

This activity occurred on May 16th, near the end of the school year and the interconnectedness of animals and plants unit. Ms. Walker loosely followed the lesson plan for an activity called "Adaptations Artistry" from *Project Wild: K-12 Curriculum & Activity Guide* (Project Wild, 2001). Earlier in the spring, I had given Ms. Walker a copy of the activity book. She had already used a few activities from the activity book during our time at Wood Nature Center such as "Oh Deer!" and "Fashion a Fish". In this

particular activity, the students were asked to create a bird. As part of creating a bird, they were expected to consider bird adaptations that would allow it to live in a particular ecosystem. According to the activity guide, "The major purpose of this activity is for students to realize that there are advantages for birds in looking the way they do and for students to recognize some of the ways in which birds are physically adapted to their environments." (p. 128)

This activity lasted approximately 3 hours. The class spent roughly two hours before lunch and one hour after lunch working on this activity. Ms. Walker began the activity by telling the students that they were going to create a bird out of construction paper. She told them that it was similar to the "Fashion a Fish" activity (Project Wild, 2000) they had done at Wood Nature Center. Ms. Walker told me that she decided to do the "Adaptations Artistry" activity because she thought that the students really enjoyed the "Fashion a Fish" activity. In the fish activity, the students were broken into groups and given specific adaptations and asked to create a fish using the provided adaptations and draw a picture of their fish. In the bird activity, the students were not told what adaptations their bird was supposed to have. Instead, Ms. Walker asked the students to think about bird adaptations such as feet, legs, beak, and body size. She also instructed the students to consider the bird's ecosystem and the ecosystem's climate and design their bird so that its adaptations would allow the bird to survive in its ecosystem. The students were asked to design a bird with a partner and create that bird out of construction paper. In other words, the final product was a bird constructed from paper.

There were several parts to this activity. First, Ms. Walker conducted a whole class discussion about the form and function of adaptations. She provided examples of

the types of bird adaptations the students needed to consider in the activity such as feet, legs, wings, body size, and coloration. For example, the class discussed how a bird with a scooped beak could swoop down from the sky and scoop up prey. They also talked about how a bird with long legs could run faster than a bird with short legs. Ms. Walker asked the students questions about the function of bird adaptations and built on student responses to help them think about form and function of adaptations that allowed a bird to survive in its ecosystem.

Next, Ms. Walker gave the students a handout with a table containing the categories: beak, feet, legs, wings, and coloration. She had the students brainstorm individually, not with their partners, about the bird they wanted to design. She asked the students to fill out the table. She also asked them to write down the ecosystem their bird lived in, the food their bird ate, its shelter, and the climate of the ecosystem. Then, Ms. Walker told the students to work with their partner to come up with the final design of their bird. The students spent some time with their partners discussing their bird design.

After some time, Ms. Walker talked to whole class about form and function again. She passed out a handout that listed a few examples of adaptations for beaks, feet, legs, wings, and coloration. For example, under feet it listed: webbed – aids in walking on mud, long toes – aids in walking on mud, clawed – can grasp food when hunting prey, and grasping – aids in sitting on branches, roosting, protection (Project Wild, 2000, p. 129). Using the handout as a guide, Ms. Walker drew examples of types of beaks and feet and talked about the shapes (form) allowed the bird to eat particular food or live in particular ecosystems. She asked the students to pick the types of adaptations their bird had and work on the design some more.

Finally, Ms. Walker passed out construction paper for the student to enact their bird design. The remainder of the activity was spent creating birds from construction paper. In other words, the students transformed their ideas into a physical paper model. Time ran out at the end of the activity and the students did not present their birds to the class.

Description of layers of analysis

As described in *Chapter 2, Methods*, there are three parts of my analysis framework: the object of the activity, the participation framework and funds of knowledge (see Figure 3). This framework builds on the framework developed by Enyedy and Golberg (2004) in their work investigating how discourse and classroom interactions shape the learning that occurs in classroom communities as the teacher and students participate in an activity. They analyze how the class constructs the goal or object of the activity, as the object of the activity is the central task the class works on as they enter into the classroom activity community of practice (Lave & Wenger, 1991) or community of learners (Rogoff, 1994). Enyedy and Goldberg use participation framework to ascertain how the classroom discourse positions the teacher and thus the roles and responsibilities for the teacher and students as they work towards the object of the activity.

I added a third part to the Enyedy and Goldberg's framework, the concept of funds of knowledge, because I was particularly interested in learning how students made connections between their everyday lives and school science. Researchers have used the concept of funds of knowledge to investigate how to connect students' everyday

knowledge and practices with school knowledge and practices (Calabrese Barton & Tan, in preparation; Gonzalez, Moll, & Amanti, 2005; E. Moje et al., 2004; Moll, Amanti, Neff, & Gonzalez, 1992). While I set forth to investigate how students drew on their funds of knowledge in school science, I found that it was difficult to ascertain the practices associated with the knowledge students drew on. In other words, the students did not provide enough information in their talk during this activity to determine what types of practices or communities of practice their knowledge was associated with/embedded within. Therefore, I modified the third aspect of my framework from funds of knowledge to everyday student resources. Below, I further explain how I defined everyday student resources and the other two parts of my analysis framework.

Object of the activity

The object of the activity consisted of multiple layers. In this activity, the students were asked to complete a final product – a bird model created out of construction paper. Completing the physical model was just one layer involved in the object of this activity. As mentioned in the description of the activity, the students were asked to consider two interrelated science concepts in their bird design: the form and function of bird adaptations and the ecosystem in which their bird lived. Below, I describe the three layers of the object of the activity that I analyzed in more detail.

Adaptations

The students were expected to think about the form and function of adaptations. In other words, the teacher wanted the students to be able to reason in a particular way about adaptations. For example, in the whole class discussion at the beginning of the activity the class discussed how birds with long legs could run faster than birds with short legs and birds with webbed feet could swim better than birds with claws, which were better adapted for grasping branches and prey. The students were asked to take into account the form and function of the bird's beak, legs, feet, wings, and coloration in their bird design.

Ecosystems

Along with thinking about the form and function of their bird, the students were expected to take into account how these adaptations enabled their bird to survive in an ecosystem. They needed to consider the affordances an ecosystem provided for a bird, specifically food, shelter, and climate. For example, the students were asked to think about whether or not the food they wanted their bird to eat was available in a particular type of ecosystem. If it was not, then they needed to reconsider the design of their bird's beak or the ecosystem where their bird lived.

Physical Task

The students worked with partners to translate their ideas about the design of their bird into a physical model. As the students constructed their physical models, they

encountered logistical dilemmas. For example, the students questioned how to actually cut and paste the various parts of their bird together and whether or not they wanted to create a two-dimensional or three-dimensional model. They wondered how create a curved beaks and strong legs out of construction paper. There was also an aesthetics aspect to the constructions. The students wanted their birds to "look good".

There was also the conceptual aspect of the construction of the model. As the students constructed their model, they were pushed to deepen their understanding of the form and function of adaptations. For example, if the students wanted to create a bird with strong, powerful wings, they needed to think about what the wings would look like and the size of the wings in proportion to the rest of the bird.

The object of the activity evolved as the students, teacher and I negotiated the multiple layers of the activity. In the analysis, I will show how the three layers of the object of the activity: (a) adaptations (in terms of form and function), (b) the concept of ecosystems, and (c) the physical task (creating a bird out of construction paper) evolved.

Participation Framework

I use the second aspect of my analysis framework, the participation framework, to demonstrate how the interactions between the students, teacher and I structure how the object of the activity is negotiated. Here, I again draw on aspects of Enyedy and Goldberg's framework. They use Cazden's (2001) notion of participation framework, "the rights and obligations of participants with respect to who can say what, when, and to whom" (p. 437) (as cited in Enyedy & Goldberg, 2004). Goldberg and Enyedy state, "People use their understandings of what type of activity they are doing and what their

role is to limit what they do and say - what people do and say has direct implications for the meaning that they take away from their experience" (2004, p. 910). They provide a traditional classroom guided by a recitation script (Mehan, 1977) as an example. In a recitation script, the teacher asks the questions, the student responds, and the teacher evaluates the students' response for correctness (I-R-E). This type of participation structure creates the teacher as the authority figure and signifies to the students when they are allowed to participate and what types of responses are acceptable.

Larson (1997) also asserts the importance of studying an activity's participation framework. She draws on Goffman's (1981) notion of participation framework, which she interprets as "a language structure that organizes and is organized by talk" (Larson, 1997, p. 502). Larson discusses how a participation framework is socially constructed over time and how the teachers and students are socialized into positions, creating a normative structure for participation.

Therefore, I examined the participation framework of this activity because it had important implications for how participants interacted with the object of the activity, or the task. I studied how the participation framework helped the class develop particular ways of reasoning about the form and function of adaptations, the characteristics and what counted as an ecosystem, and how a bird interacted with its ecosystem (how a bird's adaptations allowed it to survive in its ecosystem). Furthermore, I examined how the participation framework positioned the teacher and I as facilitators and the students as knowledgeable designers, thus influencing how we participated in the activity.

In order to investigate the participation framework, I used Enyedy and Goldberg's (2004) notion of "teacher assessments" to examine how the teacher and I (another teacher

figure) helped structure student thinking about adaptations through our feedback of student talk. Enyedy and Golberg analyzed "teacher assessments" to study how a teacher provided feedback to students as they engaged in an activity. In their study, they found that one teacher used positive teacher assessments to encourage student learning. Even when the teacher provided a negative assessment, she encouraged the student by building on the students' responses. A different teacher used negative assessments that created an activity environment where the teacher evaluated the progress of the students towards the final goal without real concern for conceptual understanding of the science concepts. They found that the teacher's assessments reinforced the goal of the activity, which although they were teaching the same lesson, differed for the two teachers.

In the bird activity, Ms. Walker and I used "teacher assessments" to scaffold student thinking about adaptations. For example, in the initial whole group discussion Ms. Walker structured the talk by (1) asking the students questions about the function of an adaptation, (2) restating or repeating student responses, and (3) extending their responses to model and/or reiterate form and function reasoning about adaptations. While this may seem similar to a traditional recitation script, it differed in many ways. First, asking the student questions provided space for the students to draw on their everyday student resources and gave them opportunities to contribute to the development of the activity. Restating or repeating student responses validated the student responses and showed the students that they had valuable resources to contribute to the activity. In other words, the students were co-constructing knowledge with the teacher and they were positioned as knowledgeable contributors. Finally, extending the student responses also validated their contributions and scaffolded student thinking about adaptations. The

teacher and I used this participation structure as we interacted with students throughout the activity.

Another aspect of the participation framework was how the teacher positioned the students through the use of pronouns and questions as she gave the students instructions. Ritchie (2002) noted that participants are positioned in particular roles through discourse. Participants can be positioned through others and/or position themselves. A participant's position influences how she/he interacts within an activity and what one learns (Enyedy & Goldberg, 2004; Ritchie, 2002). The teacher (and I) constantly positioned the students as the knowledgeable designers by asking them questions about how **they** wanted to design their bird (which also signaled to the students that they needed to consider the form and function of certain types of adaptations and aspects of their bird's ecosystem). Even when the teacher used direct instruction to remind the students of aspects of adaptations and ecosystems that they needed to think about, she provided the students with parameters to work within and expected the students to make their own bird design decisions. This, in combination with the teacher assessments, reinforced the students' position and shifted some of the power from the teacher and I to the students. It gave the students more ownership over their bird design and their learning. Furthermore, it provided the students with space to draw on their own everyday student resources of birds and ecosystems.

Everyday student resources

I define everyday student resources as the knowledge, interests, experiences, and ideas that the students bring up and draw on as they complete the object of the activity.

For example, the students talked about different types of birds they were familiar with, food sources, and how birds fly. Rhonda and Deon drew on their experience at a local nature center as they considered the ecosystem where they wanted their bird to live. Quentin talked about how he wanted his bird to have good eyesight and a good sense of smell like a hawk, characteristics that were not brought up by the teacher during whole class discussions or instructions. Some of the students' everyday resources may have come from students' experiences in previous science lessons in school, at home, or in the community. The resources may have developed from watching television, walking through a park, or participating in an activity. There was not enough information to ascertain where the students learned or formed the knowledge, interests, experiences and ideas (the community of practices) they brought up as they completed the activity. Therefore, I use everyday student resources instead of funds of knowledge to describe the knowledge, interests, experiences, and ideas the students draw on as they participate in the activity.

Analysis overview

In this analysis, I highlight how classroom interactions influence what and how students learn. I investigate the three layers of the object of the activity: adaptations, ecosystems, and the physical task and examine how the interaction between the layers of the object of the activity, the participation framework, and everyday student resources create opportunities for students to learn. I use excerpts of talk to demonstrate how these three parts of the analysis framework influence how the activity evolves and the complexity of learning and interactions that occurs in this activity.

Ms. Walker began the activity by telling the students that they would be creating a bird. She said:

> But like we did the fish where you got to design the fish, this time you're going to design a bird...

She reminded them of a previous activity they had done that was similar – designing a fish.[15] This provided the students with insight into the type of task they were expected to accomplish and connected the current task to previous lessons where students learned similar content and skills.

She went on to tell the students:

> And this time, the bird you get to design, we are going to actually going to use construction paper, cut out and gluing the pieces together to make the bird with specific adaptations. Okay.

This provided more information about the task. She told them the product that she expected, a physical bird model, and a central aspect, adaptations, that they needed to consider as they completed the task. Then Ms. Walker structured the whole class discussion to help students think about adaptations.

Student Reasoning about Adaptations – Form and Function

Through the whole class discussion, Ms. Walker helped the students develop form and function reasoning about various bird parts. This prepared the students to consider the adaptations of their bird characteristics when they created their own bird.

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[15] The previous activity, "Fashion a Fish", was an activity from *Project Wild Aquatic: K-12 Curriculum and Activity Guide* (Project Wild, 2000). This activity was described in the unit context section.

8	Ms. Walker:	Okay, before we get started on the actually creating the bird... [Ms. Walker dealing with behavior issues] Before you can actually create your bird with a specific adaptations, you probably need to know what kind of adaptations are for what. Okay. For example, if you want your bird to be the type of bird that reaches down, scoops up prey, you're gonna have to give him a scooping beak. Okay, I'm gonna have a beak that does. It can reach down and scoop up anything. [mimics bird scooping something up with beak] Okay.

Here, Ms. Walker again indicated that part of the task of creating a bird was considering its adaptations. She pointed out that students needed to know "what kind of adaptations are for what". In the discussion that ensued, Ms. Walker mentioned the kind of adaptations the students were expected to consider and helped the class reason about the form and function of adaptations, or "what the adaptations were for". In other words, she helped scaffold the students' reasoning in a specific way about adaptations. She started with the bird's beak and went on to discuss with the form and function of legs, feet, wings, and coloration.

The manner in which Ms. Walker structured the discussion helped scaffold student thinking about adaptations. She asked the students questions, restated their responses, and extended their responses. Along with scaffolding student thinking about adaptations, this played an important role in establishing the students as knowledgeable designers and validated their contributions to the discussion. I used the following coding scheme to demonstrate the teacher's assessment of student talk.

Table 3

Coding scheme for analyzing teacher assessment moves

Code	Teacher move
Bold text	Teacher question
Underline text	Teacher repeating or restating a student response.
Italic text	Teacher building and extending a student's response.
Bold and italic text	Teacher building and extending a student's response by asking another question.

Ms. Walker first provided the students with an example of what she meant by the form and function of an adaptation; she told the students that a bird that reaches down to scoop up prey (function) has a scooping beak (form) [line 8]. Then she asked the students about the function of a different type of beak, a little beak.

8	Ms. Walker:	**What do you think? A little tiny beak like this, what would a beak like this be good for? Jamal?**
9	Jamal:	I'm about to say, they got beaks like that. They seagulls.
10	Ms. Walker:	Jamal. Jamal. Seagulls' beaks *are longer, longer*. [gesturing long beak] But look at a little finch's beak. Okay, a little itty bitty finch's beak.
11	Quentin:	That one bird, that one bird on Nemo that... that um... [teacher ignores student who spoke without being called on]
12	Ms. Walker:	**A little tiny finch's beak. What would a tiny little beak be good for?**
13	Sam:	Worms? Worms?

14	Ms. Walker:	Okay, maybe gettin some worms. *Maybe getting in the ground and gettin some worms.*
15	Student 2:	Or it could... [inaudible]
16	Ms. Walker:	Okay, the pecking, get the termites out or something. Shhhh. **Think about, think about what the birds, what the little, think about the bird seed. What do the bird, the little tiny beaks like this, what do they need to do?** They need to crack...
17	Student 3:	Seeds.
18	Ms. Walker:	They need to crack the seeds, don't they? ***If I had a giant, big scooping beak, is it gonna be real useful at cracking the seeds***?
19	Student 4:	Yes.
20	Student 5:	No.
21	Student 6:	No.
22	Ms. Walker:	No. No no no no no. *I need something sharp and something small and accurate that I can grab a seed in my beak and snap it.* [snaps fingers] Gentlemen, put that away. Think about a hummingbird. **Why do you think a hummingbird has such a looong, skinny little beak?** Sam?

While Jamal did not provide a function for a tiny beak, Ms. Walker used Jamal's response to explain why she did not think a seagull had a little beak [lines 9-10]. She repeated and built on his response. She used Jamal's answer to clarify what she meant by a small beak. Ms. Walker continued this process of (1) asking the students a question, (2) repeating or restating student responses, and (3) building on student answers. In line 12, Ms. Walker asked the students about the function of a tiny beak like a finch's beak. Sam gave a response and Ms. Walker repeated and extended upon his response [lines 13-14]. In line 15, a student provided another possible function for a tiny beak. Again, Ms.

Walker presumably repeated it and expanded upon it to demonstrate how the students should reason about the form and function of beak adaptations. In line 16, Ms. Walker asked about the function of tiny beaks again. She repeated a student's response and extended upon it in lines 18. She also compared the form and function of a small beak to that of a scooping beak to further demonstrate the different forms and functions of beaks [lines 18, 22]. When Ms. Walker compared the two types beaks, she again followed the same pattern of asking a question, restating student responses, and extending their responses.

By asking the students questions, Ms. Walker provided the students with opportunities to draw on their everyday resources (i.e., knowledge, ideas, experiences) as they considered bird adaptations. It also positioned the students as valuable contributors to the discussion. Repeating student answers further acknowledged their responses as valuable contributions. Even when a student did not give the answer the teacher was looking for, as in Jamal's case, she still repeated it and explained why the answer was not correct, which clarified her question. Furthermore, when Ms. Walker restated and expanded upon student answers, she helped the students reason about the function of, in this case, a bird's beak. The combination of asking students questions, restating student answers, and building on them to scaffold the students reasoning about form and function helped the class co-construct their knowledge and understanding of adaptations. It provided space for students to draw on their everyday student resources and merge them with the school science.

The students drew on their knowledge of what birds ate such as worms, termites, and seeds; types of birds such as seagulls, hawks, ducks, and ostriches; and experiences

such as trips to a local nature center as they designed their bird. In the very beginning of the discussion, Jamal instantly associated a type of beak with a bird he was familiar with, a seagull [line 9]. Quentin associated seagulls with a movie he was familiar with, *Finding Nemo* [line 11] (Stanton & Unkrich, 2003). Later in the discussion when Ms. Walker brought up webbed feet without providing an example of a bird with webbed feet, a student immediately made a connection to a type of bird with webbed feet.

33	Ms: Walker:	Think about the webbed feet. **If I have these super skinny little feet that are just like twigs am I gonna be a very good swimmer?**
34	Students:	Nooo. [in unison]
35	Ms. Walker:	No. *I need some webs in my, if I want my bird to be a good swimmer, I'm gonna need some webs so that my bird can swim real fast.*
36	Student:	Like a duck.
37	Ms. Walker:	Like a duck. *They have some webs.*

The students made connections between their everyday resources and the activity, which often occurred when students connected an adaptation of a particular animal characteristic (type of feet) to an animal with which they were familiar. In the excerpt above, Ms. Walker asked the students a question, repeated their responses, and built on their responses. In this case, she validated a student's connection to a familiar bird and scaffolded their reasoning about the form and function of feet.

During this discussion, she also asked students about short and long legs. She provided an example of a type of bird that had long legs, an ostrich, and asked if it could run fast. When the class responded "Yes", the teacher explained why by comparing and contrasting the affordances and constraints of short and long legs. After discussing the

form and function of the beak, legs, and feet, Ms. Walker asked the students, as individuals, to brainstorm the types of adaptations their bird would have.

> Ms. Walker: So what I want you to do right now, what I want you to do right now, I want you to close your eyes and I want you to think without your partner... Your beak. What kind of things **do you want your bird** to be able to eat. Just in your head. Shhhhhh. In your head. Monique, not with your partner. This is your vision of your bird that you're creating. Don't share. What, **how do you want** your bird's feet? **Do you want** a swimming bird, a running bird, a long-toed bird that can grasp things and hang easily? **What do you see** for your bird's feet? Just keep it in your head. What about your bird's legs? **Do you want** short legs? **Do you want** really long legs, **do you want** big muscular legs? What about its wings? **Do you want** really large wings? Or **do you want** some smaller wings? Coloration? What colors? **Do you want** it very bright so that it attracts a mate? Or **do you want** it very bland and brown so that it can blend into its surroundings? **Do you want** a bright colored one that attracts mates and attention or **do you want** a brown one that blends in?
>
> *Bold added to emphasize instances where the teacher positioned the students as knowledgeable designers through her talk.

Here, Ms. Walker signaled the types of adaptations she wanted the students to consider in their bird design and reinforced form and function reasoning about adaptations. She asked the students to consider the bird's beak (form) and what kinds of things their bird would eat (function); the bird's feet (form) and if the feet would help the bird swim, run, or grasp (function); if the bird's legs were short, long, and/or muscular (form); the size of wings (form); and bright, colorful coloration (form) that could help the bird attract a mate (function) or bland, neutral colors (form) that could help the bird camouflage (function). The teacher allowed the students to design their own bird, but she wanted them to think about the form and function of the bird and provide explanations for their bird design.

Importantly, Ms. Walker questioned the students about what they wanted their bird to be like. Her questions scaffolded the students' thinking about the form and function of adaptations. By asking the students what they wanted their bird to look like,

she also provided space for students to draw on their everyday student resources to create their bird and positioned them as knowledgeable participants and designers of **their** bird. As she gave instructions, she constantly asked the students to think about what **they wanted** their bird to look like and where **they wanted** their bird to live. She said, **"How do you want"** or some variation of this 13 times in her directions. By emphasizing the notion that the students were to decide what they wanted to do, she distributed some of the authority from herself to the students. Ms. Walker provided guidelines, but she put the onus on the students to design their own bird.

As the activity continued, the students worked with their partners to design their bird. Ms. Walker and I walked around the classroom to monitor the students' progress. We asked the students questions about their bird design. The following was an interaction I had with a student as he considered his bird's adaptations.

102	Blakely:	**Okay, if it's on water though, if it's in water, what type of feet do you think it's gonna need?**
103	Darius:	Fish.
104	Blakely:	**What type of feet?**
105	Darius:	Oh, uh, webbed feet.
106	Blakely:	Mm hm. Probably webbed feet. *Because in, if it's gonna go through water, like if you think about the type of feet that ducks have...*

Here, I used the same participant structure to help scaffold Darius' thinking about form and function that Ms. Walker used in the whole group discussion at the beginning of the activity. I asked Darius a question about the design of his bird's feet. Then I repeated Darius' response and built on it to include the form and function of webbed feet. In other

words, I used his answer to reason about why webbed feet would help his bird swim. The teacher and I had other similar types of conversations with students about their bird designs. We asked students questions and built on their responses to help scaffold their reasoning about the form and function of bird adaptations, positioned the students as knowledgeable designers, and provided space for the students to draw on their everyday resources.

After the students spent time working with their partners on their bird design, Ms. Walker gave the whole class further instructions about how to turn their design into a physical model. She showed the students what various bird adaptations (forms) would look like by drawing examples of bird adaptations on the overhead projector. She also gave the students a handout that listed a few types of adaptations for beaks, feet, legs, wings, and coloration. For example, under beak, it listed pouch-like, long and thin, and slender and long. Ms. Walker used the handout to guide her instructions and drawings.

> Ms. Walker: Now... on this piece of paper on one side we're going to draw **so you know what it's talking about. If you said**... Shhhhh. This is the part where **you're gonna have to listen if you want to get it right**. [dealing with behavior] This is the part right here, Jerome, Quentin, that **if you don't listen and apply these attributes to your, these characteristics to your bird, then your bird's not going to make sense.** So this right here is a key part. **If you said, your bird** eats fish it's going to need a pouch-like beak. Kind of like a pelican is an example. So I'm going to draw a picture of what a pouch-like beak out be. And you're going to draw the picture too. Okay, the pouch-like beak that can hold, it can hold its fish inside. Like a pelican. Draw that. [Ms. Walker drew example on overhead, students copied example on handout] You need to know this. **If you want**, Lila, **if you're looking at a bird** that can dig into the soil to get bugs, then **you're going to need** a long, thin beak so it can get into the soil.
>
> *Bold added to emphasize instances where the teacher positioned the students as knowledgeable designers through her talk.

Ms. Walker reinforced form and function reasoning about adaptations as she helped the students understand how to turn their designs into physical models. She drew examples

of different types of beaks, feet, legs, and wings and discussed the form and function of the different bird adaptations. In this case, Ms. Walker provided direct instruction. She did not ask the students questions and build on their responses as she did in the initial whole class discussion; she reinforced the earlier whole group discussion of adaptations with pictures and direct instruction. Even though Ms. Walker was using direct instruction to make her points, she still positioned the students as designers. She told the students that they needed to listen so they could design their bird correctly. She said things like, "If you said your bird..." and "If you want..." Ms. Walker positioned the students as designers – the ones making the choices – as she helped them think about the form and function of their bird adaptations.

After she finished drawing the forms of bird adaptations and while students were working on their bird designs, Ms. Walker and I talked about the adaptations that the students could use in their bird design. From discussions with students, I knew that some students wanted to create birds that had features that were not listed on the sheet or discussed in class. For example, in class Ms. Walker asked the students to think about whether they wanted their bird to have large or small wings. Some students thought that these were the only two options for the form of wing. We talked about whether or not the students could design a bird with adaptations that were not specifically mentioned in class (e.g., medium sized wing) and decided that they could as long as they provided an explanation for their bird adaptation. In other words, the students needed to be able to justify their bird adaptation using form and function reasoning. Ms. Walker gave the following instructions to students.

227	Ms. Walker:	Alright, 5, 4, 3, 2, 1, 0. Now, I was just told from someone who has done this before, cause I have not done this before... that **you can** combine different things in order to make **your animal** work. But the key point is, **if you combine** two different things, **you have to be able to explain why you combine those two different things**. So, **if you want** your bird to be a very fast runner, **you can** have the strong legs. **But you also want your bird** to be able...
228	Student:	To fly
229	Ms. Walker	**But you also want your bird** to be able to carry prey. It's gonna have to be strong.
230	Jamal:	How's it gonna carry prey?
231	Ms. Walker:	Or you, **so you would be able** to combine them. **If you wanted** different feet and different legs? [question directed at Blakely]
232	Blakely:	Mm hm.
233	Ms. Walker:	Right.
234	Blakely:	Or different, like a medium sized wing or something... or...
235	Ms. Walker:	Shhhh.... shhhh. [directing student who came into room late] So **if you wanted** to make a bird that could hold fish and could also break apart bark, **you could** take the two and blend them together to make an appropriate beak. So it could have a pouch but it could also may such its pouch in or do something to its pouch so it could get into trees. **But you have to be able to explain why**.

*Bold added to emphasize instances where the teacher positioned the students as knowledgeable designers through her talk.

Ms. Walker explained to the students that they were allowed to come up with adaptations that were different from those discussed in class or on the worksheet as long as they could reason about the form and function of an adaptation. The students, using me as a vehicle, broadened the parameters or constraints of the activity in terms of what was

acceptable as a type (form) of adaptation. In other words, they drew on their own interests, in terms of the types of adaptations, to negotiate acceptable adaptations.

Again, Ms. Walker gave the students direct instructions for how they could design their bird adaptations and reinforced the students' position as the designers. She told the students that if **they** wanted particular types of adaptations (forms), then **they** would need to justify the function of the form. She said, "you can combine two different things..." "If you want your bird to..." and "you have to explain why..."

As the activity progressed, the students picked up on form and function reasoning about adaptations. After drawing pictures of bird adaptations, Ms. Walker talked about what a bird she designed might look like.

250 Ms. Walker: It's beak is going to be big, okay scoopy

251 Student: Scoop up its prey.

252 Ms. Walker: To scoop fish. To scoop its prey, which is its fish.

In line 250, Ms. Walker suggested that her bird would have a scooped beak. A student added that the bird with a scooped beak could scoop up its prey. Ms. Walker further built upon this by adding that it uses its beak to scoop up a specific type of prey, fish. Thus, the student recognized that when considering adaptations, one needed to think about both the form and function of the adaptation. In other words, the student picked up on form and function reasoning about adaptations.

Another student demonstrated his reasoning about form and function.

> Sam: I wanted it to have long and strong legs. Ms. Tsurusaki! I wanted it to have long legs so it could run fast and be, so it could be strong. [line 465]

When Sam told me what he wanted his bird to look like, he justified his choice of form by explaining the function. Other students also demonstrated their reasoning about form

and function. For example, Quentin told me how his bird's good eyesight and sense of smell helped it sense prey. This example will be discussed in more detail in the *Ecosystems* section.

Ecosystems

The students also needed to consider the ecosystem of their bird, another layer of the object of the task, as they designed and constructed their bird. In the first whole group discussion, Ms. Walker and the students talked about the form and function of legs, feet, wings, and coloration. Then Ms. Walker gave students a piece of paper to write down the characteristics of the bird and its habitat that she wanted them to consider in their design. She wrote words such as ecosystem, food, shelter, and climate on the overhead projector, which the students copied down on their own paper. Ms. Walker told the students that they should write something down for each category. This helped the students think about what they needed to include in the design of their bird.

37 Ms. Walker: Right now, these are the things I want you to write on the back of your paper. What type of ecosystem your bird's gonna be from. What type of food will be available in your ecosystem for the bird to eat. **I want you to think**, what types of shelter will be available for your bird in that ecosystem? **I want you to think** what the temperature, is it gonna need a big furry coat? Or is it gonna not need a lot, or not furry, downy fur? Or is it going to need um, very light thin feather because it's warm? **So I want you to think** about the temperature there. You know what you guys can do? I know how we can make this easy. So, this is my first time doing this guys. So...

38 Monika: Do you want us to draw it?

39 Ms. Walker: No no no no no. I want you to write it. Put a dash next to

these words so that you can explain the ecosystem and you can write down rainforest. The food that's available there, the shelter that's available there, the temperature, so what type of...

40 Student: Weather.

41 Ms. Walker: Yeah, what's the temperature there? Is it cold, is it warm, is it wet. Okay. Describe all that stuff. Um... **I want you to think about**, is water available? Or will it need to have some kind of a system to store water or to preserve water or is there water all around readily available for it. Um, whether it's going to be, whether it's going to be able to survive best on the land? Like a penguin doesn't fly. It survives best on the land. Okay. It has no need for flying up above because it eats fish. Right? And I imagine too that if you get up there, in the arctic, in the air, I imagine it's way too cold up there. Okay, all that wind flying by, I'd... So **you need to decide**. Is it a land bird? Is it, is it a sky bird. Like if I lived in the um... air.. rainforest, I could want to be able to get to the canopy level where all that wildlife lives. Um, air or land.

42 Student: I put land or sky.

43 Ms. Walker: Land or sky, yep. Land or that would actually make better sense. Sky or land. My pen is dying on me. And let's see, **what else do we need to think about**? **We need to think about food**... Whether you want it, if it's going to be a land bird, then you're gonna want some good legs on it. Oh, sky or land or water. What if it's a water bird like a duck?

Ms. Walker built on the class discussion of the form and function of the bird's beak, feet, legs, and coloration. She told the students that they needed to consider the ecosystem where their bird lived. They needed to consider the food and shelter available in the ecosystem and the ecosystem's climate [line 37]. In other words, Ms. Walker wanted the students to think about how their bird's adaptations helped it survive in its ecosystem.

When Ms. Walker was giving directions she said, **"I want you to think..."** four times. She also said, **"What do we need to think about..."** and **"You need to**

decide..." Ms. Walker gave the students parameters for the things they needed to consider in their bird design (and its ecosystem), but provided space for the students to make their own design choices. She positioned them as the responsible designers, which distributed some of the authority from herself to the students.

Ms. Walker also picked up on what students said and incorporated their talk into her instructions. In line 39, Ms. Walker asked the students to consider the food, shelter and temperature of their bird's ecosystem. A student said, "Weather", and the teacher acknowledged this and continued talking about the weather in the ecosystem. Ms. Walker restated temperature and then extended this when she mentioned cold, warm and wet, descriptors of weather. In line 41, Ms. Walker told the students that they needed to decide if their bird was a "land bird" or "sky bird" but wrote air or land on the overhead projector. A student suggested "land or sky" [line 42]. Ms. Walker acknowledged that these descriptors made more sense and used them instead. Ms. Walker and the students picked up on each other's talk. Ms. Walker validated the students' suggestions and positioned them as knowledgeable co-constructors of the object of the activity – in this case how the class talked about ecosystems.

After the whole class discussion and teacher directions, the students worked on their bird design with their partners. Ms. Walker and I monitored the students' progress. Ms. Walker and I had conversations such as the following with students.

52	Ms. Walker:	[to Rhonda and Pam] Now, in the meadow, are there many trees in the meadow or is it mostly tall grass?
53	Rhonda:	Tall grass.
54	Ms. Walker:	In the meadow there's a lot of tall grasses.

55 Rhonda: [Inaudible]

56 Ms. Walker: Yeah, yeah. Cause there's not a lot of trees in the meadow. The meadow's pretty open and airy. You might find one or two... well you guys have to decide on the same bird. You're going the same bird. Okay?

Here, Ms. Walker asked Rhonda and her partner, Pam, about their bird's ecosystem. Rhonda and Pam had chosen a meadow as the ecosystem and Ms. Walker asked questions to probe their understanding about a meadow ecosystem. She questioned them about the types of flora existed in a meadow. In this activity, the students were expected to think more deeply about the ecosystem; they could not just list the type of ecosystem their bird lived in such as meadow or rainforest. The students needed to consider the affordances an ecosystem provided for their bird in terms of food and shelter.

Here, Darius and his partner thought about how their bird's adaptations would allow it to survive in its ecosystem.

109 Darius: Shelter.

110 Sara: Why you keep saying that [inaudible]?

111 Darius: I don't know. Shelter.

112 Sally: In the water.

113 Darius: Nooo. Sleep like this [gets on floor to demonstrate his bird curling up]

114 Blakely: [laughs] Okay, what's gonna happen if there's a big storm?

115 Sally: Um, cage.

116 Darius: Hide in the water.

117 Blakely: Huh?

118 Sally: Caves, there's caves.

119 Darius: Probably get in the water.

120 Blakely: I don't know. What to you guys think? It's your, it's your guys bird.

121 Darius: He can live in, hide in caves.

122 Sally: That's what I said.

Darius and his partner considered the shelter that their bird's ecosystem would provide for their bird. Sally and Darius both offered suggestions for their bird's shelter and I questioned their ideas to help them think more deeply about whether or not their ideas would actually provide shelter for their bird [line 114]. While I questioned their ideas, I did not tell them what to do. They looked to me for validation of their ideas, but I reminded them that it was their bird and they needed to decide what type of shelter their bird needed [line 120].

Occasionally throughout the activity, Ms. Walker would interrupt the students' work and provide additional reminders or instructions for the whole class. Here, Ms. Walker reminded the students of aspects of their bird's ecosystem that they needed to consider.

> I want you guys to think about this for the temperature. Does it have seasons? Is there going to be a hot, dry season or a cold, wet season or it is cold and wet all the time? Or is it hot and dry all the time? Or is it cold and wet all the time? Okay? Think about that. Will the bird need to be able to change and maybe lose some of its feathers for the summertime? What do you think? [line 74]

Ms. Walker reminded the students to think about the temperature and seasons of their bird's ecosystem. Further, she connected the relationship between bird adaptations and its ecosystem. She said, "Will the bird need to be able to change and maybe lose some of

its feathers for the summertime?" The students needed to think about how their bird's adaptations suited it for survival in its ecosystem.

Ms. Walker also gave examples such as:

> A slender and long [beak], like the hummingbird. That's so it can get nectar from flowers. And I want to say if you, if your bird lives in the rainforest, what, I mean there is nectar everywhere in the rainforest. So you're probably gonna want a bird that eats nectar. [line 182]

Here, Ms. Walker provided an example of how the form and function of a bird's beak was suited for a particular ecosystem, a rainforest. She explained that if the students wanted their bird to eat a particular type of food, such as nectar, their bird should live in an ecosystem where that type of food was abundant. Below, Ms. Walker reiterated the notion that students needed to consider their bird's ecosystem.

> You're creating a brand new species. And you have to think, what type of ecosystem will my bird live in? What it's going to need to survive. What kind of **food** is it going to eat? So how could I make it's beak and claws so that it could get that food. What type of **temperature** is this ecosystem? What is the overall **climate** of this ecosystem? And how will I need to adapt my bird's body covering. Those of you just coming in, just stand in the back. You're also going to need to look at, where your species is going to find its **shelter**. So what kind of covering is your species going to need to be so that it can camouflage in its area? But you also have to look at what kinds of colors will your species of bird have so that it can attract a mate. You need to think about what the body shape of your species is going to be. Will it be a large bird or a smaller bird? **We all know what a living thing needs to survive. And you will need to, when designing your new species, keep all those things in the back of your mind, because when you're done you're going to have to explain how the body parts of your new bird are going to help it survive in that environment.** Okay? So look at your area. Is it **artic** year round? Or does it have a **cold season** with snow and a **dry season** with a lack of water. And you're going to design your bird so it can survive in the that type of environment. [line 429]
>
> *Bold added to emphasize aspects of an ecosystem Ms. Walker mentioned.

Ms. Walker reminded the students that they needed to consider the interaction of their bird's adaptations and its ecosystem. In this excerpt, she mentioned aspects of an

ecosystem that the students needed to consider: food, temperature, climate, shelter and seasons. As she mentioned the different aspects of an ecosystem, she talked about how bird adaptations helped the bird interact and survive in its ecosystem. For example, she again mentioned that a bird's beak and claws helped it obtain the available food in an ecosystem. She discussed how a bird's coloration could help it camouflage with its environment, thus providing protection. Ms. Walker emphasized that the students needed to think about what living things need to survive. Earlier in the unit, the class learned about how living things need food, shelter, air, water and space to survive. In this instance, Ms. Walker emphasized food, shelter, and water and prompted the students to think about what animals need to survive.

Consistent with her manner of addressing the class, Ms. Walker provided the students with parameters that they needed to consider - questions they needed to ask themselves - as they created their bird. She used questions and statements to help scaffold student thinking about the relationship between adaptations and ecosystems. In the process, she positioned the students as designers and herself as a facilitator by saying things like, "What do you think?" [line 74[, "...if your bird..." [line 182], and "you will need to, when designing your new species" [line 429].

Rianna and Deon took into account the type of food available in an ecosystem as they considered where their bird would live.

131 Rianna: Look [to Blakely], Ms. Walker [the teacher] said that there won't be fish in the forest. That there's like a little pond

132 Deon: Yeah like when we went to Wood [nature center]. There was like a pond that we went to and birds went there to catch fish. See and Ms. Walker told us there won't be that kind of water there.

133 Blakely: What type of water did you say?

134 Deon: Like a pond.

135 Rianna: Small little pond.

136 Deon: With fish in it.

137 Blakely: What, so why did she say there wouldn't be water?

138 Rianna: She said there wouldn't be water in the...

139 Deon: Cause we put it in the forest.

140 Rianna: Ms. Walker [trying to call her]

141 Blakely: So she said there wouldn't be water in a forest.

142 Rianna: In the, there's no fish.

143 Deon: Yeah. And we put fish for food.

144 Rianna: [raises hand, trying to get Ms. Walker's attention]

145 Blakely: Okay, there can be ponds, or lakes in forests.

146 Rianna: But she said there wasn't.

147 Blakely: So she might be thinking that they're different ecosystems.

148 Deon: Okay, so...

149 Blakely: ...Might be what she's thinking? So she might be thinking that either you have your pond ecosystems or a forest ecosystem. So maybe what you want to do is put that it lives in both? Is that what you're trying to say?

150 Rianna: Yeah.

151 Deon: Yeah.

152 Blakely: That it lives in a pond and a forest?

154 Deon: [nodding head] That's what we say.

Rianna and Deon wanted their bird to live in an area that had both a pond and a forest, like the ecosystem that they had seen at a local nature center. When they asked the teacher, she told them to pick either a pond or a forest as an ecosystem. Earlier in the year the students had learned about ecosystems. The class had talked about ecosystems at a macro-level such as desert, arctic, and rainforest. During this time, they talked about the types of animals that lived in these ecosystems, their adaptations, and the ecosystems' climates. They did not discuss the notion of scale of ecosystems. Ecosystems can be very small or very large. Ecosystems are generally considered to be a group of living and nonliving things that interact with each other. While Ms. Walker might have been thinking about a pond and a forest as separate ecosystems, Rianna and Deon considered the pond within a forest to be one ecosystem. Both were correct applications of the concept of ecosystems.

The students' position as knowledgeable designers provided space for Deon and Rianna to draw on their experiences to challenge the teacher's notion of ecosystems. It not only gave them power, but they also presented a stronger argument for their case because they reasoned about the affordances and constraints of ecosystems and what this would mean for their bird. Rianna and Deon's drew on their knowledge of ecosystems, some of which stemmed from experiences such as their trip to the local nature center, to consider interaction between birds, their adaptations, and ecosystems during this activity. They had considered the food and shelter that was available in a forest and pond ecosystem that was necessary for their bird to survive. When the teacher told them to pick either a pond or a forest, Rianna and Deon could have accepted the teacher's idea of an ecosystem and chosen either a pond or a forest as their bird's ecosystem. Instead, they

continued to plead their case with me and used their own experiences and reasoning about bird interactions with ecosystems to support their case.

The following interaction with Quentin was another example of a student considering how his bird interacted with its ecosystem. Throughout this activity, students excitedly came up to me to tell me about their bird. Quentin actually came up to tell me about his bird twice.

155 Quentin: Ours is gonna have a good sense of smell.

156 Blakely: It is?

157 Quentin: Yeah, so because our prey is like far away. And when it's coming, it's gonna have good, it's gonna have good eyes like an owl.

158 Student: Quentin. It's gonna have three...

159 Quentin: When the thing comes, it sees it, I mean it sees it, camouflages. Then next thing, it's getting closer and closer and then chhh [sound of his bird eating its prey]

In Quentin's bird's design, he thought about the form and function of various bird characteristics and how these adaptations helped his bird survive in its ecosystem. He told me that his bird was going to have a good sense of smell and provided an explanation for why his bird needed a good sense of smell. Because his bird was hunting for prey from a distance – presumably the bird was flying the air and its prey was closer to the ground – his bird needed not only a good sense of smell, but good eyesight. It also needed to blend in with its surroundings so it could sneak up on its prey. Thus, he considered three characteristics – smell, eyesight, and a camouflaged body – in the design of his bird that were all important in order for his bird to catch prey. He had thought about the affordances that particular bird characteristics would provide in his bird's

ecosystem. It was especially significant that Quentin considered his bird's sight and olfactory abilities because Ms. Walker did not bring these up during her framing of the activity nor did she mention it to the whole class at any point throughout the activity.

In our second conversation, Quentin expanded on his bird's design.

282 Quentin: Our bird's gonna be a hawk. Ms. Tsurusaki, our bird's gonna be a hawk.

283 Blakely: Hmm?

284 Quentin: Our bird's gonna be a hawk.

285 Blakely: Your bird's gonna be a hawk?

286 Quentin: Yeah, it's gonna be green so it can blend in, it's, it's, it goes through the rainforest and camouflages in the bush. Because that's its shelter. It's gonna, the bird gonna be green, blue, with red dots to make it look like berries on a tree. So when prey comes [makes eating noise and opens mouth wide to swallow prey]. And it's gonna have eyes, it's gonna have eyes like an owl to see the prey. And it's gonna like smell real good.

287 Blakely: It's gonna what?

288 Quentin: Smell real good.

289 Blakely: Uh huh.

290 Quentin: And so when it sees the prey it closes its eyes but then it smells get closer and closer and then it eats it.

291 Blakely: Ahh.

During this second conversation, he provided more details of his bird. He said that he chose a rainforest as his bird's ecosystem. Because his bird lived in a rainforest, he decided that it needed to be green and blue so that it could camouflage with the bushes and trees. He said that the bushes provided shelter for his bird. He even went as far as to think about red dots, which would mimic the berries in trees. He also reiterated that his

bird needed good eyesight and a good sense of smell so it could see and smell its prey from far away.

It was evident that Quentin was thinking deeply about the design of his bird and its ecosystem. In both conversations, he showed that he had thought about the form and function of various characteristics of his bird that were all essential to its survival. While it was unclear what the origin of the knowledge he was drawing on to create his bird was, he had some knowledge of a hawk and its good eyesight and sense of smell and used this as a basis for his bird's design. In other words, he drew on his everyday student resources. He also knew that some birds swoop down from the air to catch its prey, which Quentin acted out with his hands and sounds during both conversations. Thus in these brief conversations, Quentin demonstrated his knowledge and reasoning about form and function that he used to help him complete the task. He also talked about how his bird's adaptations allowed it to survive in its ecosystem and included the affordances of the ecosystem he chose. He drew on his knowledge and ideas within the parameters of this activity. In other words, he worked within a hybrid space where he merged his everyday student resources and the school science activity.

Physical model

The students were expected to create a final product at the end of the activity – a physical model of their bird – another layer of the object of the activity. As the students created their model, they continued to discuss their bird's adaptations and ecosystem but there was an added aspect of how to turn their ideas into an actual model. Darius and

Sally wanted their bird to have powerful legs. They worked on cutting legs out of construction paper.

296	Darius:	This look like a good powerful leg? [shows Blakely his drawing on his paper]
297	Blakely:	Hmm?
298	Darius:	Does that look like a good powerful leg?
299	Blakely:	Mm hm.

The students asked for my validation of their bird's physical legs. They also asked for help constructing their bird.

310	Jamal:	How you like supposed to make the bird?
311	Blakely:	What do you mean how are you supposed to make it?
312	Jamal:	Like, is it supposed to be like a full body?
313	Blakely:	You guys can be creative and make it how you want. So like if you want it to be...
314	Jamal:	I don't...
315	Blakely:	um, okay, explain to me what you think. Like what you think you want to do.
316	Jamal:	Like I was saying like... Like we wanna make it like so if like you can see the whole bird. Like so the bird was like, so it's like, it's real but it's fake. Do you get it? Looks like the real bird, as big as the real bird. Like that and it's got like, like what the body is, the body is...
317	Blakely:	So you can either make it, if you want you can make it 3 dimensional...
318	Jamal:	Yeah, that's what I'm talking about.
319	Blakely:	Okay. So you can if you want. Or you can make it flat, like make it two-dimensional.

Here, Jamal asked me how the students were supposed to physically construct their bird. We talked about creating a two-dimensional or three-dimensional model. Thus, part of the task was determining how to turn the students' bird designs into physical models. Once Jamal decided that he wanted to create a three-dimensional model, he asked for further help.

323	Blakely:	**Tell me what you want to do**.
324	Jamal:	Like I want just this bird.
325	Blakely:	Okay, **what type of body? What shape is it?**
326	Jamal:	Like, the wings.
327	Blakely:	Okay, so...
328	Jamal:	The wings are the, are the, powerful strong wings.
329	Blakely:	Okay, ***so what do they need to look like to be powerful and strong?***
330	Jamal:	[shrugs] I don't know.
331	Blakely:	**Do you think they're gonna be tiny little itty bitty...?**
332	Jamal:	No, they're real big.
333	Blakely:	Okay, they're probably going to be big, right? *So why don't you draw you, why don't you draw your wing on here* [on construction paper].

Jamal wanted to create a bird with powerful wings. He needed help figuring out what powerful wings looked like. Ms. Walker had drawn pictures of the form of some adaptations to help the students visualize what various forms would look like, but Jamal needed further guidance. Instead of telling him what to do, I asked Jamal questions about how he wanted to create his bird and probed his thinking about the form and function of

his bird's wings [lines 323, 325, 329, 331]. While I did not always repeat what he said, I acknowledged his responses by building on them to help him reason about his bird or provided instructions for how to physically make his bird with construction paper.

One challenge of constructing a physical model was the pragmatic aspect of the task – how to physically cut out and glue together the model. While this presented a challenge, building the model also pushed the students to think more deeply about their bird's adaptations. Jamal decided that he wanted his bird to have strong and powerful wings, so he was forced to consider what strong and powerful wings looked like. In other words, he needed to think about the form of the wings. Jamal needed to connect the form and function of his bird's wings in order to turn his ideas about his bird into a physical model.

We continued to talk about how to turn Jamal's ideas about form and function into a physical model.

337	Blakely:	...so once you have your body, say you have your body. We're just gonna pretend, say this is your body, right? When you want three dimensional, you can make your wings so they stick out from it. Does that make sense? When you make you wings stick out. And you'll probably make pretty big wings because it's pretty powerful?
338	Jamal:	I don't know how to make them though. Like what shape.
339	Blakely:	So I would use a pencil first, before you start cutting so you know what you're doing. Okay.
340	Jamal:	But then, like, what shape should they be?
341	Blakely:	**So what shape do you think they should be?** *Think about a bird. And think about what shapes they are. ...* ***What does the shape of a wing look like that's big and powerful...?***
342	Jamal:	Well they like curl up like this [motions with arms]

343 Blakely: Okay.

344 Jamal: Cause some falcons, they go like this and they leave like this and when they fly real fast they curl them up like this and they go real fast.

345 Blakely: *Okay, so why don't you think about that and try and draw that. Like picture it in your head and then draw it.*

Jamal had to think about the physical construction of the model (cutting and pasting construction paper) [lines 337, 339, 345] and the form and function of his bird parts [lines 338, 340-344]. Instead of telling Jamal the form of his bird's wings, I asked him what how he thought the bird's wings should look. This provided Jamal with space to draw on his knowledge of how birds with strong wings fly and what they look like [lines, 342, 344]. He used this to create his own bird's wings out of construction paper.

In another instance, Dominic and Ebony attempted to figure out how to build their physical model.

389 Ebony: The wings are too small. What are you doing?

390 Dominic: [cutting wings] Remember our wings would be little cause it's light.

391 Ebony: That doesn't look right at all.

392 Dominic: [inaudible]

393 Ebony: Ms. Tsurusaki, we need help.

394 Blakely: What do you need help with?

395 Dominic: YOU need help.

396 Ebony: Because, do you think the wings would go good on this big body?

397 Blakely: I don't know. What do you think?

398 Ebony: I do, and he's just cuttin em. Look at it.

399 Blakely: Okay, if you think about it, is your bird going to be able to fly?

400 Dominic: Yes.

401 Blakely: So what size wings would you need for the body?

402 Dominic: Small.

403 Blakely: So it would be able to fly?

404 Dominic: Small!

405 Blakely: Okay, Dominic. If you had really tiny wings and a big body, so you think it'd be very helpful to get you off the ground? If you only had little wings? Think about proportions, right? Okay, so you would want wings that would be big enough that it would help the bird be able to fly, right?

Here, Ebony and Dominic had to think more deeply about the form and function of their bird's wings in order to make their physical model. Ebony and Dominic disagreed about how large their bird's wings should be and asked for my help. Dominic wanted to make little wings because they were light [line 390]. Ebony was concerned with whether or not the wings "looked right" [line 391] and about the size of the wings in relation to the size of the bird's body [line 396]. Instead of telling the students what to do, I asked them to think about proportions. The students needed to consider how large to make their wings depending on the size of the bird's body.

Many students drew the outline of their bird parts on the construction paper before they cut them out. Here, Deon asked for help drawing his bird's beak.

502 Deon: We need help drawing the beak though.

503 Blakely: What kind of beak do you want?

504 Deon: Curved.

505 Blakely: You can draw a sketch of a curved beak then.

506	Deon:	See look. That's our thing.
507-521		[Blakely talking to students about behavior]
522	Blakely	... Cause it's curved. What does it mean if it's curved? Exactly.

Unlike Jamal, who asked for help figuring out what the form would like for a particular function, Deon just wanted help drawing the form of a type of beak. Some students had difficulty drawing what they envisioned their bird to look like. Thus, there was the added layer of the students' artistic abilities.

Some students like Jamal were concerned with the aesthetics of their model.

568	Jamal:	Our bird looks retarded.
569	Blakely:	It doesn't look retarded.
570	Owen:	Well, you're a teacher. You're supposed to say that.
571	Jamal:	I know. You're supposed to say that.
572	Blakely:	It does not. Remember you are creating, you know how crazy some birds look? Just like lots of, there's lots of animals that look pretty crazy, right? That doesn't mean they're retarded.
573	Jamal:	This one is.
574	Blakely:	Nooooo.
575	Jamal:	It's gonna walk, look, it's gonna walk straight. Like... [imitates how his bird would walk]
576	Blakely:	Okay, Jamal. Now, now that would be pretty silly. Then, do you think your bird would survive very long if it kept doing that? It'd probably get eaten by all the other predators out there.
577	Jamal:	It's about to get eaten.

Interestingly, Jamal was concerned with how his bird looked and he also translated that into how the bird would walk [line 575]. In other words, he considered how the form would affect the function.

The students had to figure out how to translate their ideas the form and function of their bird into a physical model. This included aspects such as considering what the form of a particular function of a bird part looked like, how to draw a particular form, and the aesthetics of their bird. In some instances the students had to think more deeply about their bird's adaptations in order to build their models.

Discussion and Implications

In the analysis, I attempted to demonstrate the complex nature of the activity. First, the object of the activity consisted of multiple layers. The students were expected to create a final product, a physical bird model. In order to create a model, the students were expected to consider the form and function of various bird adaptations and how those adaptations enabled the bird to survive in an ecosystem. Thus, they needed to learn how to use form and function reasoning when thinking about adaptations. They also had to consider the resources available in ecosystems such as food and shelter. Further, the students needed to think about the interaction between adaptations and ecosystems. Finally, the students were expected to translate their ideas about their bird adaptations and its ecosystem into a physical model. This required solving logistical dilemmas such as how to draw different features and sometimes pushed the students to think more deeply about their bird's adaptations.

The participation framework shaped how the object of the activity evolved during the lesson. The analysis showed the important role that the participation framework played in the development of student understanding of adaptations, ecosystems, and their interactions. The teacher scaffolded student reasoning about adaptations through discussions by (1) asking the students questions about the form and/or function of a bird part, (2) restating or repeating student responses, and (3) extending student responses. Along with helping the students develop form and function reasoning, this also positioned the students as knowledgeable contributors to the development of the activity and classroom discourse. Furthermore, it provided space for the students to draw on their everyday student resources and have those resources validated and reshaped into scientific ways of thinking. The teacher also positioned the students as knowledgeable designers when she gave the students direct instructions. She continually asked the students to think about their design and what they wanted their bird to do. The teacher told the students that they needed to consider the food and shelter available in their bird's ecosystem and its climate. Even when the teacher gave the student direction instructions, they were in the form of parameters. In other words, Ms. Walker provided guidelines for the things that she wanted the students to think about but the students needed to decide how to actually create their birds and justify their design.

The object of the activity, the participation framework, and everyday students resources were constantly negotiated throughout the activity. In other words, what is accepted in terms of how the students participated in the activity community evolved and was shaped by classroom interactions.

Hybrid spaces

This work stemmed from hopes of discovering more about how students and teachers draw on students' funds of knowledge (or in this case, everyday student resources) in school science. It aimed not only to discover how connections between school science and students' everyday lives occurred, but also how hybrid spaces were developed. Analysis showed that it was very difficult to study students' funds of knowledge in this science activity. It was hard to ascertain whether or not the resources students drew on were funds of knowledge because I could not determine the practices associated with student knowledge, ideas, interests and experiences. Determining the communities of practices knowledge is embedded within is a central aspect of funds of knowledge (Gonzalez, Moll, & Amanti, 2005; Moll, Amanti, Neff, & Gonzalez, 1992). Moll and his colleagues conducted ethnographic interviews to determine students' funds of knowledge and then developed curriculum specifically around those funds of knowledge. My research raises the question about how teachers can use already developed curriculum and make connections to students' funds of knowledge.

From other interactions with these students in both formal and informal settings and student interviews, the students talked about practices such as watching movies and television, cooking, gardening, playing sports, and taking care of pets. But these practices did not provide insight into students' practices and knowledge related to birds and ecosystems, a traditional school science topic. Thus, how can teachers ascertain and draw on students' funds of knowledge in their daily science lessons using developed and/or mandated curriculum? Furthermore, are there topics that students may not have relevant funds of knowledge to draw upon?

While this analysis did not tap into students' funds of knowledge, it did show how students drew on their everyday student resources and created hybrid spaces where they merged their everyday resources and school science. It raises three key points with regards to creating hybrid spaces.

First, the teacher needs to create space for students to draw on their resources. In this activity, this meant asking the students about what they knew about birds, adaptations, and ecosystems. It also required shifting some of the power from the traditional authority figure in the classroom, the teacher, to the students. The teacher positioned the students as knowledgeable contributors instead of passive participants. While the teacher was still the primary knower and authority of the object of the activity (she decided the initial task and its parameters), the students were positioned as authorities in charge of designing a bird. Through teacher and student interactions, the students saw that their knowledge was a valuable resource for this activity. The teacher provided parameters for the task, but did not tell the students exactly how to complete the activity. The students were responsible for making design choices and providing rationales for their choices. This provided the students with space to draw on their student resources to reason about the form and function of bird adaptations.

Other research on third/hybrid spaces supported the idea that in order for hybrid spaces to occur, there needs to be a shift in power (Calabrese Barton & Tan, in preparation; K. Gutierrez, Rymes, & Larson, 1995). In the case of this activity, this did not mean giving the students complete control to do whatever they desired. While the teacher and I encouraged them to draw on their everyday student resources, we also wanted them to provide explanations for why they designed their birds in particular ways.

We continually asked and told the students to explain why an adaptation would help their bird live in an ecosystem. Thus, the students were challenged to draw on their resources to help them think scientifically about adaptations and ecosystems.

Second, the teacher needs to carefully scaffold student learning to create a bridge between everyday student resources and school science. Researchers have discussed the importance of scaffolding student learning (e.g., Collins, Brown, & Newman, 1989; Lave & Wenger, 1991). In this activity, the teacher helped the students develop their reasoning about the form and function of adaptations, characteristics of ecosystems, and the relationship between adaptations and ecosystems. For example, she asked the students questions about the form of adaptation and built on student responses to extend their understanding. This helped scaffold the students' entry into the community of learners. Asking the students questions, restating their responses, and extending them validated students' resources and contributions as members of the community. Other research also acknowledges the important role building on student responses plays in helping students enter into a learning community (e.g., Cazden, 1988; Wells & Arauz, 2006).

Finally, creating hybrid spaces is a complex process. There are multiple, interacting layers in an activity. In this activity, the teacher scaffolded student understanding of adaptations, ecosystems, the relationship between adaptations and ecosystems, and the physical construction of a model. There were whole class discussions, teacher-student interactions, and student-student interactions that all played a role in how the activity evolved. There were cognitive, social, and emotional factors (although I did not address emotional factors such as student mood) that influenced the learning that occurred. Furthermore, these aspects were not static. They continually

evolved as the activity progressed. There was evidence that students developed form and function reasoning about adaptations, but this was no small feat. While hybrid spaces may be difficult to develop and foster, further research can help educational researcher and teachers gain insight into how to foster communities where hybrid spaces can develop.

CHAPTER 4

Bee Model Building Activity

Background

One of the activities in the curriculum materials that the school district recommended for 4th grade science was building a bee model. This activity was part of a unit on plants. In the plant unit, the students learned about the different parts of a seed and what a seed needs to germinate, and the different parts of a plant and what a plant needs to grow. As part of learning about flowers, the students learned about how insects, specifically bees, help pollinate the flower of plants so plants can produce fruits. A month prior to the bee model building activity, the teacher had conducted a pre-assessment with students to find out what they knew about bees. She made a T chart and had "What we know" in the first column and "What we wonder" in the second column. One student knew quite a bit about the three types of bees; she was held back a year and had learned about this in her 4^{th} grade class last year. Students knew about that bees live in bee hives, bees sting humans, bees die when they sting a person, and bees make honey out of nectar. One student said that bees "like rust and metal" because she usually saw bees around playgrounds (that have rust and metal). Another student said that baby bees were born in honeycombs. He said that he saw this on a television show. The students had experiences and knowledge about bees prior to learning about bees in school. Ms. Walker encouraged the students to give answers about what they "knew" even if other students did not think something was true. She told them it did not matter if it was right or wrong; she wanted to know everything students' knew about bees. Ms. Walker said

that they would do some experiments to find out if they were right or wrong. The students were excited to share what they knew and were upset when this portion of the lesson was over.

Ms. Walker moved on to "what we wonder". The students wondered if bumblebees were bees, how baby bees grew their wings, and if the queen bee was bigger in size than the other bees. After talking about what the students wondered, Ms. Walker gave the student the guiding question for their bee exploration in the middle of the plant unit. The question was, "What do bees do to help a plant in its life cycle?" She told the students that during their explorations of bees they would answer some of the students' questions, but they were going to focus on the bee's role in the plant life cycle. Then she asked the students to draw a scientific drawing of a bee. Ms. Walker did not provide them with an example drawing. She did emphasize that a scientific drawing included labels and many details. Along with their scientific drawing, the students were supposed to include a written explanation of what they thought a bee looks like. Some of the students completed this assignment, but the teacher did not go over the drawing with the students as individuals or a class.[16]

The activity analyzed in this chapter, the bee model building activity, took place on March 14th, 2007 in the science lab. The lesson occurred a month after the bee pre-assessment discussion of "what we know" and "what we wonder".[17] The teacher did not review what the students had talked about in the pre-assessment. The bee lesson began

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[16] I looked at students' drawings and descriptions in their science notebooks. Some students had the beginnings of a drawing, but most were lacking labels and descriptions of what bees look like.

[17] I use lesson to denote the entire time spent in the science lab. The lesson includes reading the bee trade book, the bee skit, the time spent examining the bee specimen and the bee model building activity. In my analysis, I analyze portion of the lesson, the bee model building activity.

with the teacher reviewing the parts of the plant with students. She then read the students a book, *I wonder what it would be like to be a bee*. The book talked about different types of bees and how bees help pollinate plants. Then the teacher had two students act out a skit of bees pollinating flowers. Next, the students were given a bee specimen to examine with a hand scope. The students were given an identification sheet that consisted of pictures of the three types of bees and their names (drone, queen, worker). The teacher told the students to try to identify their bee. The students only spent a few minutes looking at the bee specimens and teacher did not spend time discussing the specimens with the students. Finally, students made a bee model. The teacher handed out sheets with the parts of the bee that the students, as individuals, were to label, color, cut out, and put together.

The teacher spent approximately 2 hours on the entire lesson. Approximately an hour and 14 minutes of that time was spent on the bee model building activity.

Chapter overview

In this chapter, I first demonstrate how the teacher constructs the object of the activity: the task and its parameters. I then examine how the interactions between the teacher, students and I reinforce the object of the activity. I also provide some examples of students' failed attempts to negotiate the object of the activity.

Next, I examine the participation framework. I look at how the teacher uses pronouns, in the context of directives, to position herself in as an authority figure and the

students as passive followers. I also investigate how the teacher and I reinforce our positions as authorities through our assessments of (responses to) students.

Then, I discuss how the students rarely draw on their funds of knowledge during this activity and do not draw on their funds of knowledge in meaningful ways. In other words, their funds of knowledge do not help them complete the task and the students, teacher and I did not create hybrid spaces.

Finally, I summarize the object of the activity and participation framework and how they work together to create opportunities for students to learn. I also reiterate how the students drew (or did not draw) on their funds of knowledge and create hybrid spaces. I end with a brief discussion of missed opportunities to create more meaningful conceptual understandings of the science.

Object of the Activity

Framing the activity: The task and its parameters

Right before this activity, Ms. Walker had two students act out a brief skit where a bee pretended to pollinate a flower. The reviewed the parts of the flower and then told the students, "...then we have the parts of the bee and that's what we're studying today." This told the students that their next task had to do with learning about the parts of the bee. Although Ms. Walker told the students that they were going to learn about the parts of the bee, she did not tell them how they were going to learn about them. She passed out two sheets of paper containing parts of the bee to each student. Each piece of paper contained the outline of several parts of the bee, such as a leg, an antenna,

the abdomen, etc. Then Ms. Walker started giving directions to the whole class. She said:

> Okay. I need you guys to use your pointy finger. So put your pointy finger, so put your pointy finger in the air. Look at, what my abdomen looks like. Put your finger on the abdomen of your paper. And right next to it write the word abdomen. A-B, oh, it's written up there for you. A-B-D-O-M-E-N [spelling out the word for students].

Ms. Walker placed one of her handouts on the overhead projector, pointed to the abdomen bee part on the overhead to show students where it was located on the handout, and told the students to label the abdomen on their handout. Ms. Walker then pointed to the thorax, told students to label it, and spelled thorax for the students. Ms. Walker structured the activity in a procedural manner. She emphasized the identification and labeling of the bee parts. She took the students step by step through the identification and labeling of bee parts. She did not ask the students if they knew the names of various parts; she directed the students to point to the bee parts on their handout and label it. Ms. Walker's framing of the task signified that, for this portion of the task, the goal was to correctly identify and label the parts of the bee. In order for the students to complete this task, they needed to follow Ms. Walker's directions. During this time, I walked around the room to check to make sure students were labeling parts correctly. This added to the notion that the task was correctly identifying and naming the parts of the bee.

When Ms. Walker talked about the abdomen and thorax, she did not discuss their form and functions. She brought up form and function for the first time when she expanded upon the labeling process with the proboscis. After pointing to and spelling proboscis, she said:

> The head... 5... 4...[18] The head has a very looong, pointy thing. That is the proboscis. It's what the bee uses to get the nectar. It's the loooong thing on there. Not the shorter one. The shorter one's the antenna.

Ms. Walker talked about the location of the proboscis in relation to the rest of the bee; she told them that the proboscis protruded from the bee's head. She also described the function of the proboscis; the bee used the proboscis to get nectar. Ms. Walker said that it was long and pointy, which implied that this enabled the bee to procure nectar. This was one of the few times Ms. Walker mentioned the form and function of a bee part. She did not continue this line of reasoning to other parts of the bee.

When Ms. Walker talked about the legs of the bee, she spent the majority of the time focusing on labeling the pairs of legs correctly and the order of the legs. This, along with Ms. Walker's emphasis on correctly labeling the parts of the bee, indicated that the students were supposed to build an accurate model of a bee. In order to build their model, the students were supposed to follow the teacher's directions.

Reinforcement and negotiation of the object of the activity

Teacher and student reinforcement of the task

The notion that the students were supposed to build an accurate bee model and follow the teacher's directions continued throughout the activity. After the teacher identified the parts of the bee and had students label them, she moved on to the coloring of the bee parts.

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[18] The teacher began a countdown from 5 until 0, but did not complete it. This was a classroom management technique used by many of the teachers at this school. When students were being too loud and/or the teacher wanted the class' attention, she/he would count from 5 until 0, with the idea being that the students needed to be quiet and paying attention to the teacher by the time she/he reached 0.

Ms. Walker: I'm passing out crayons for you to color.

Student: Uuuu, crayons.

Ms. Walker: Are you allowed to color your bee purple?

Students: Yeees.

Ms. Walker: Nooo. There's no purple ones in Michigan.

Student: Ahhhh.

Ms. Walker: ** Gimme 5... 4... 3... 2... 1.. 0. Nice job, team 5. Nice job, team 6. 3 and 4. We're studying the honeybee. The honeybee's going to be yellow, black, brown.

Jamal: No.

Denis: Yes.

Ms. Waker: The honeybee is not green, purple. The honey bee is yellow, black, brown. Alright. So that's what I expect to see.

** The teacher counted down from 5 to 0. As previously mentioned, this was a standard practice used by all teachers in the school to get the class' attention. In this same line, the teacher commended various team numbers. In the science lab, students usually worked in groups, or teams, and each team was assigned a number that corresponded to the number at a lab table.

In the introduction, Ms. Walker focused on correctly identifying and labeling the bee parts. Here, she talked about correctly coloring the bee parts. In the coloring portion of the activity, Ms. Walker did not tell the students which color to use for each part, directing them part by part as she did with the labeling of parts. She simply directed them to use yellow, black and brown and the students started coloring. Immediately, students asked what color they should use for the thorax. Ms. Walker told them to color the thorax either brown or black. A little while later, Ms. Walker told the whole class:

> The wings I want you to outline in black. Outline in black. Just like trace over the lines in black and leave em white. Leave the wings white. Just trace them in your black.

This supported the notion that the students were supposed to create an accurate bee model. It needed to be labeled and colored correctly. Ms. Walker also wanted the students to color neatly. She said:

Boys and girls, I expect nice coloring cause this will be on display.

A few seconds later, she said:

Your best coloring. This is going to be on display.

Again, the task was to create an accurate model of a bee. Instead of thinking about the parts of the bees and their form and functions, the students worried about doing their best coloring. The conversation between Lakesha and me served to reinforce the task and its parameters.

Lakesha: Is this supposed to be yellow and that supposed to be black?

Blakely: Okay, this is the part where you think about bees being striped. This is the part where'd be balck and yellow.

A conversation between Rianna and I also supported the task.

Rianna: I messed up.

Blakely: What's wrong?

Rianna: I did this wrong. I messed up.

Blakely: How'd you mess up? You didn't mess up.

Rianna: Uh huh.

Blakely: What'd you do that was messed up?

Rianna: Color all the lines in one color.

Blakely: Color what?

Rianna: Color over all the lines in one, in one.

Blakely: Oh, that's fine.

Dominic: Make em darker.

Blakely: Oh, don't worry about it. No, that's fine. You don't have to see lines on this one.

Rianna worried that she had colored her model incorrectly. Throughout the coloring portion of the activity, the students, teacher and I were concerned with accurately and neatly coloring the bee parts. This reinforced the object of the activity – that the students were making an accurate bee model.

After the students finished coloring the parts of the bee, the teacher asked them to cut out and assemble the parts of the bee. Similar to the labeling of the bee parts, she went through each part that she wanted the students to cut out and assemble one by one.

> Ms. Walker: Alright boys and girls. Taking a check here. We have... [inaudible] We have five more coloring minutes. I'm going to pass out scissors, but do not start cutting or you will lose pieces. I don't have your attention. I am passing out scissors, but do NOT start cutting or you will lose pieces and then you're going to say, "Why does my bee only have four legs? Why is my back leg in the front?" [said in high pitched voice] Don't cut til I tell you to cut, okay?

Ms. Walker went through and told the students which part to cut out and where to glue them, which again emphasized that the task was to create an accurate model following her instructions.

Student negotiation of the task

While the teacher, students, and I reinforced the object of the activity, there were instances when students pushed against the task. During the labeling portion of the activity, Ms. Walker did not spend much time talking about the form and function of the bee parts. Instead, she focused on correctly identifying, labeling, and ordering the parts.

Ms. Walker: The other leg goes in the middle. But none of them are attached at the abdomen. No legs are attached to the abdomen. They're all attached to the thorax. Okay? First is the one with the antenna cleaner, last is the one with the pollen basket.

Shanika: What's second?

Ms. Walker: The wings are also attached to the thorax. Nothing is attached to the abdomen. Absolutely nothing is attached to the abdomen.

Jamal: What is the abdomen for? What is the abdomen for then?

Ms. Walker: I don't know. Good question.

Jamal asked a question about the function of the abdomen. This was one of the few student questions that asked for more than how to label or color a bee part. Unfortunately, while the teacher recognized the question and said, "Good question," she did not know the answer and the inquiry ended there. Neither the teacher nor the students pursued this line of questioning.

During the coloring portion of the activity, one student wanted to color a bee part differently than the teacher directed.

Ms. Walker: The wings I want you to outline in black. Outline in black. Just like trace over the lines in black and leave em white. Leave the wings white. Just trace them in your black.
Lila Can you make em a little yellowish?
Ms. Walker: Um, they're clear. They're clear, so... Yep. Trace em.

Lila, who was known by the class and teacher as being a very good artist, asked if she could color the wings differently than Ms. Walker directed. Ms. Walker would not allow it. Ms. Walker wanted the students to make accurate bee models using correct colors and how she instructed.

Another student became frustrated while making his bee model and asked for my help. This occurred during the cut and assembly portion of the activity.

Quentin: I need help!

Blakely: What? You're doing just fine. Right?

Quentin: She's [Ms. Walker] not even explaining nothing. Mmmmm!

...[Blakely helping another student]...

Quentin: I wanna put these on next.

Blakely: Yeah. Oh, you wanna put it on after? Then go ahead.

Quentin: We can cut it out?

Blakely: What?

Quentin: We can cut it out?

Blakely: Go ahead, cut that one out.

Ms. Walker told the students to cut out various body parts and assemble them one at a time. While this may seem like a small act of rebellion, Quentin said, "I wanna put these on next." He decided he wanted to put different parts on his bee model next. In other words, he did not want to follow Ms. Walker's instructions regarding which part to cut out next. Most students asked where to put different bee parts, what to do next, or if they had done something correctly, but Quentin made a declarative statement. He asserted some agency, but then he asked me if he could cut it out. Thus, Quentin pushed at the procedural nature of the activity, the notion that the students had to follow the teacher's directions, but he also fell back on it when he asked me if he could cut out the part.

Summary of object of the task

Framing of the activity

For this activity, the task was to create an accurate model of a bee. Ms. Walker told the students that they were going to learn more about the parts of the bee. She connected this activity to previous lessons on plants and flowers, where they had learned about parts of the plant and the parts of the flower. When the students had learned about the parts of the plant and flower, they learned about the function of the parts of the plant and flowers and how they helped the plant grow and reproduce. In this activity, Ms. Walker framed the task as creating an accurate bee model, but did not include learning about the form and function of the parts as an element of the task as she did when she taught about the plants, flowers, and also seeds. The task was to create an accurate bee model using the provided outlines of bee parts and to follow the teacher's instructions to complete the model.

In the pre-assessment lesson, Ms. Walker had the students create a scientific drawing of a bee (but she did not go over the parts of the bee with the class). In this activity, she did not have the students refer back to their drawing in their science notebook. Also, earlier in this lesson the students briefly examined a bee specimen. Ms. Walker did not have the students refer to the bee specimen as they made their bee model. Furthermore, in the bee pre-assessment lesson Ms. Walker told the students that they were learning about bees during the plant unit because bees help plants pollinate. In this activity, she did not make any connection between the bee model and how creating a bee model would help students understand how bees help plants pollinate. The task was to learn the parts of the bee, which has value. But there were many missed opportunities to

connect to other activities the students had done and to include things like learning about the function of bee parts that might have made this a more meaningful science activity.

This analysis was not meant to criticize the teacher. She enacted a lesson that was included in the curriculum as part of the plant unit based on her understandings. Also, teachers often has the best intentions of making connections to other lessons and/or a driving question, but schedules change (which can result in a month lapse between the pre-assessment and this activity), one might have to deal with behavior issues, and many other distractions occur through the school year, day, and lesson.

Reinforcement and negotiation of the task

The teacher, students and I reinforced the task and its parameters throughout the task. Ms. Walker and I told the students how to color the different parts of the bee and when to cut out and paste the parts together. Students followed the directions and checked with Ms. Walker, me, and each other to make sure they were following the directions correctly. A few students occasionally pushed against the task. Jamal pushed against the task when he asked about the function of the abdomen because learning about the function of the body parts was not emphasized in this task. Lila tried to negotiate the parameters of the task when she asked if she could color the wings differently than Ms. Walker had directed. Quentin resisted the teacher's directions and wanted to put his bee together in a different order. These were all instances of the students' unsuccessful attempts to negotiate the task and its parameters.

Participation Framework

Establishing positioning and power

Ms. Walker positioned herself as the person in authority in this lesson. She told the students what to do. From the start, she said:

> Okay. **I** need **you** guys to use your pointy finger. So put your pointy finger, so put your pointy finger in the air. Look at, what my abdomen looks like. Put your finger on the abdomen of your paper. And right next to it write the word abdomen. A-B, oh, it's written up there for you. A-B-D-O-M-E-N [spelling out the word for students].

Most of Ms. Walker's instructions were given as directives. When she gave directions, she said, **"I** need **you..."** which served to assert her authority. She continued to give directions, saying things like:

> **I** want **you** to put your finger on the thorax of your bee. And over there **I** want **you** to write thorax.

And,

> Okay, on your... paper. You're gonna see a head with a proboscis. **I** want **you** to put your finger on the proboscis and write proboscis.

She told the students what each part was, the name of the part, and how to spell the name. *She* told *them* what *she* wanted them to do. She did not ask the students questions about the parts of the bee, such as what part they thought it might be or what they thought the function of a part was. Through her talk and actions, she implied that she held the knowledge that the students needed to know. In other words, Ms. Walker told them the information they needed to complete this activity and the students needed to pay attention to what she was saying in order to make sure they were completing the task correctly.

Reinforcing and negotiating positioning and power

As the activity continued, Ms. Walker told the students that she wanted them to color the bee the correct colors, which further reinforced her position. This continued as Ms. Walker gave direction during the cutting and pasting part of the task. Ms. Walker told the students that she did not want the students to cut out any bee parts until she told them to. This served a very practical purpose – she did not want the students to lose parts. If students lost parts, they would not be able to complete their model accurately. Ms. Walker proceeded to give a direction, wait for students to complete the direction, and then give another direction. The following was her sequence of directions.

> Now, whether you're done coloring or not, **I** need **you** to cut out along the dotted line, cut out the thorax. The next step is to cut out the first legs. The ones with the antenna scrapers.
>
> .....
>
> One's in the back [referring to the legs], one's in the back like this. And one on the front of it. And one on the back. Like that. [instructing students how to put legs on]
>
> .....
>
> Next step is to cut your head out. You can see the dotted line where the head attaches. Okay, there's a dotted line on the front where the head attaches. There's also a dotted line where the abdomen attaches. Okay, so I attach. Okay, so I attach this.
>
> .....
>
> Alright. Next step. Now **we** need to cut out the big legs. The big legs that go on the back of the thorax. They are the legs that have the honey basket on them.
>
> .....
>
> Okay, here it is on my picture of my bee. Notice, I left room right here for my middle legs. I also left the second dotted line so I could hook on my abdomen.
>
> .....

> Okay, **we** need to get our middle leg on. ... One again, I'm doing one to the front, one to the back.

Ms. Walker continued to say things like, "**I** need **you**" or "**I** want **you**", but she also said things like "Now **we** need to cut out the big legs" and "**We** need to get our middle leg on..." Even though Ms. Walker said things like "**we** need to..." she still gave directives. She told the students what they needed to do; she told them exactly how to complete the task. Thus, she maintained her position of authority and reinforced the students' position as passive followers.

Teacher assessments

The teacher assessments also served to establish and reinforce the teacher's (and my) position of authority. In the beginning of the activity, Ms. Walker's directions focused on identifying and correctly spelling bee parts. Ms. Walker very rarely asked the students questions. When she did, it was to make sure the students understood her directions. The students did ask questions. Their questions revolved around correctly labeling the parts. For example, one student asked me which legs he was supposed to be labeling. I told him which legs to label. The students asked if they were doing something correctly and the teacher and I gave them yes or no assessments. I used the following coding scheme in Table x to show patterns in teacher assessments.

Table 3

Bee activity coding scheme for analyzing teacher assessment moves

Code	Move
Bold text	**Student** question
Italicized text	Teacher told student answer or acknowledged student as completing task correctly or incorrectly
Underlined text	Teacher corrected student

The coding scheme for this activity was different from the coding scheme used in the other two activities. In this activity, the teacher rarely asked the students questions. The students asked the teacher, me, and other students questions about how to correctly build their models. Thus, the student questions were coded using bold text. Also, the teacher and I did not typically build on student responses like we did in the bird and pond activities. We told the students whether they were building their models correctly or incorrectly. If they were building their model incorrectly, we corrected them. Therefore, I used italicized text to indicate when the teacher and I told the students if they were building their model correctly. Underlined text represented when the students were not building their model correctly and the teacher and I told the students how to do it correctly.

In the following instance, Pedro asked me if he had labeled a part correctly.

Pedro: Ms. Tsurusaki. **Isn't this the thorax?**

Blakely: *Yeah.*

Pedro: Told you! [to another student]

I responded affirmatively. This was a typical interaction that occurred between students and I during this activity. Another student, Lakesha asked me the name of a bee part. I told her what the part was.

Lakesha: **What is that then?**

Blakely: What?

Lakesha: **What is that thing?**

Blakely: What is what thing? What? What are you pointing at? That is... I need to go look. *Okay. Look it here. Pollen combs. Right here. These? Okay. See how these look like little combs? These are the pollen combs. Pollen baskets.*

Ms. Walker and I did not ask the students questions to help them try to figure out the answer themselves. We told them whether they were right or wrong or simply told them the correct answer. This positioned us both as the evaluators of the students' work and the ones holding the knowledge.

Reinforcing teacher assessments

Ms. Walker and I continued to give the students assessments that reinforced our position as authority figures. After Ms. Walker gave directions, she and I went around the room attempting to help students. The following dialogue was characteristic of the talk that occurred as students were working on their models.

Jamal: **Ms. Walker, which one are we cutting out?**

Ms. Walker: *You're cutting out the wrong one.* You need to cut out these. These are the front, these are the antenna cleaners.

Jamal: You told me to cut these!

Ms. Walker: No, I didn't. Okay, you wrote it down wrong.

Typically a student such as Jamal would ask which body part he or she was supposed to be cutting out, coloring, or gluing or where a body part went. The teacher or I would respond to a student's question by telling him or her if he or she was right or wrong. If a student were wrong, we would tell the student what to do.

Students would also often ask they were doing some thing correctly.

Ebony: **Did I color them wrong?**

Blakely: *No, they're fine. Yeah. They're fine.* Cut out these ones.

Here, Ebony asked me if she was coloring her bee parts correctly. Again, the teacher and I served as evaluators, telling the students if they are doing something correctly. Thus, our position as authority figures and the students' position as passive followers were reinforced through interactions between the teacher, students and me.

Summary of participation frameworks

The teacher positioned herself as the authority figure in this activity. She started by telling the students what to do. She said things like, "**I** want **you**..." She did not ask the students questions; she gave them directives.[19] The students reinforced the teacher and my position as authority figures through the types of questions they asked. They asked us questions about whether or not they were completing the task correctly. They also asked us questions about how to complete the task correctly. This also served to position the students as passive followers. The teacher and I further positioned ourselves

[19] This differed from the bird activity when the teacher said, "I want you to think about..." In that case, the teacher asked the students to consider certain questions as they designed their bird and was scaffolding students thinking about the form and function of parts of the bird.

as authority figures and as holding the correct knowledge through our responses to student questions. When student asked us questions, we told them whether or not they were completing the task correctly. We evaluated their progress toward the completion of the task, but did not evaluate their understanding of the parts of the bee.

Funds of knowledge and hybrid spaces

Making connections to knowledge about bees

In the next two sections, I described how the framing of the task and the participation framework provided (or did not provide) opportunities for students to make connections to their funds of knowledge.

Although students were familiar with bees and most had first-hand experiences with them (i.e., being stung by bees or seeing them in their yards, on the playground, etc.), they rarely drew on their experiences during this activity. Most of the student talk centered around correctly completing the assignment (or occasionally arguing over supplies). The teacher framed the task in a manner that limited the opportunities for students to draw on their funds of knowledge.[20] The students were supposed to build an accurate model of a bee. They were provided with sheets of paper with the outlines of the bee parts draw on them. The teacher went through and told the students the name of each part. In the second portion of the activity, the students colored the bee parts. Ms. Walker told the students to use the correct colors to color the bee parts. In the final

[20] This is not meant to be a negative judgment of how the task and how the teacher framed the task. There is value to the task and using directives to instruct students, depending on the task. It comment is simply meant to show how the framing of the task provides certain opportunities for learning.

portion of this activity, Ms. Walker went through piece by piece and had the students cut out and glue the parts together to make the final product. She used directives and rarely asked the students questions throughout the activity. When the students asked questions, they asked questions about whether or not they were completing the task correctly. The combination of the object of the task and the participation framework did not provide many opportunities for students to make connections to their funds of knowledge.

There were a few students who did bring up their funds of knowledge related to bees. I interrupted the following conversation that some boys were having.

Blakely: What about mosquitoes? What's wrong? You're gonna die of bees?

Darius: I'm gonna die if I don't get no more gum.

Blakely: Oh, if these are extinct we're gonna die?

Anthony: Yep.

Blakely: Why do you say that?

Anthony: Because oxygen.

Blakely: Because we get oxygen from the bees.

Anthony: Yes.

Blakely: Do we get oxygen from the bees?

Anthony: The plants.

Blakely: The plants. Actually, um, they've had a lot in the news lately about honeybees and how there are less honeybees for some reason and they're trying to figure out why? Because you know how we talk about how bees pollinate all the crops?

Anthony: Yeah.

We went on to talk a little bit more about how bees help flowers pollinate and how this affects some of the food we eat. We had an interesting discussion about the resources that bees and plants provide for humans and the interconnectedness of life. While we were talking about bees, this did not help the students complete the task.

Similarly, Darius brought up an interesting story he had heard about bees.

Blakely: Where you at, Darius?

Darius: I'm still on my head. I don't wanna do this.

Blakely: Why are you still on your head?

Darius: Cause I don't wanna do this.

Blakely: Yeah, but.. Come on. You can do this.

Darius: Everybody hates bees.

Blakely: You shouldn't hate bees. You should love bees. Bees provide us with honey. They pollinate our plants so that we can have food to eat.

Darius: They provide us with carbon dioxide. Did you hear about that thing in Africa where all the people die from carbon dioxide?

Blakely: From carbon dioxide?

Darius: Yeah.

Blakely: When was that?

Darius: 2004

Blakely: I didn't hear about it. What happened?

Darius: Carbon dioxide spreading around Africa and the... like 2000 people died.

Blakely: Oh, that's not good. So we need bees that will pollinate our plants so they will live and be healthy.

We had an interesting conversation about bees. We talked about how bees are beneficial and harmful to humans. But like the previous example, Darius' knowledge about bees did not help him complete the task.

Meaningful learning – Merging funds of knowledge and school science?

Students held many funds of knowledge about bees, as evidenced by the pre-assessment conducted prior to this activity. They also brought up some interesting funds of knowledge during the activity. But these funds of knowledge were not relevant to this task. They did not help them build an accurate model of a bee. Thus, there was not evidence of students drawing on their funds of knowledge in meaningful ways. In other words, the students were not able to create hybrid spaces where they merged their funds of knowledge and the school science in significant ways during this activity.

Conclusions

Object of the activity

The task of this activity was to build a bee model. The teacher set the parameters of the activity – the students were supposed to build an accurate model of a bee and they were supposed to follow her directions in order to complete the task correctly. The teacher first had told the students the name of each part of the bee and directed the students to label them. This indicated that the students that the task was to correctly label the parts. The notion that the students were supposed to create an accurate model was

reinforced throughout the activity as teacher told the students to color neatly using the correct colors and when to cut out and glue the parts together.

The teacher's task and parameters made sense because the students had not really learned about the parts of the bee prior to this activity. The analysis was not meant to criticize the teacher and her decisions about the task or how she framed the task. As mentioned, this activity was part of the district curriculum. The analysis was meant to show the affordances and constraints of an activity that come from aspects such as the object of the activity. There could be value to having students create an accurate model of a specimen. For example, this activity along with previous activities related to this one could have created opportunities for students to learn about the form and function of bee parts. In other words, the students could have learned about bee adaptations that helped them pollinate flowers. This object of the activity lacked a purpose for why the students needed to learn about the parts of the bee.

Participation framework: Positioning and power

Through her interactions with the students, the teacher positioned herself as the authority figure who knew the correct way to complete the task. She told the students how to label, color and cut and paste the bee model. She used directives; she said things like, "**I** want **you**..." The teacher also rarely asked the students questions. When she did ask the students questions, she asked them if they understood her directions. The students also positioned and reinforced the teacher's position as the authority on the task. They asked her questions about whether or not they were completing the task correctly.

I also positioned myself and was positioned by the students as an authority figure with right answers for how to complete the task. Student also asked me whether or not they were completing the task correctly. The responses or assessments the teacher and I gave students further reinforced our power and authority. We evaluated how well they were completing the task. Through the participation framework, the teacher, students and I limited the students' opportunities to co-construct knowledge and understanding of bee parts and their form and function.

Interrelatedness of object of task and participation framework

In my analysis, I separated the object of the activity and the participation framework. These aspects of the activity are intertwined. The following was an example of how the task and the participation framework worked together to create student learning experiences.

While the students were working on their models, I walked around the classroom assisting the students. The following exchange occurred during this time. As often happened in this classroom, multiple students were talking to me and competing for my help at the same time.

352 Anthony: I'm like way, way behind.

353 Blakely: Where's your other leg [talking to another student, not Anthony]?

354 Anthony: I'm way behind.

355 Don: Is this the way it goes? Ms. Tsurusaki?

356 Blakely: Hold on one second.

357 Don: I think she [Ms. Walker] said do something like this. [to another student]

358 Anthony: I'm like way behind.

359 Blakely: It's okay. You're good. [to Anthony]

360 Don: Does the head go like this?

361 Blakely: Okay, the head...

362 Don: Does it go like this? Or like, I can't tell.

363 Blakely: This. Can you take this off? And this is gonna go right... like that.

364 Don: And then where does this go then?

365 Trevor: Like under.

366 Don: But then where does this go?

367 Blakely: This also, it can't go on top right? It can't go on that side.

368 Don: That can't be.

369 Blakely: Mm hm. Legs.

370 Don: But doesn't there have to be one on this side also?

371 Blakely: Um, but we're doing a side view. So if you're looking at the side, they're both going to come down. If we were looking on top, then one would go this way and one would go that way. Right? We're doing the side view.

372 Anthony: I don't want my [inaudible], but I'm so tired.

373 Blakely: That's okay. You're doing great, Anthony. You're doing just fine.

374 Anthony: I'm way behind.

375 Blakely: Why are you way behind?

376 Anthony: I don't know where anything needs to go.

This dialogue consists of two strands: Anthony and Don. Anthony kept repeating over and over again that he was behind in the activity; he repeats it five times interspersed throughout my exchanges with him and other students [lines 352, 354, 358, 374, 376]. He seemed to think that he was not keeping up with the teacher and the rest of the class in the procedures. When I asked him why he thought he was behind, he replied," I don't know where anything needs to go." In other words, he did not know how to correctly build his bee model.

Anthony's discourse brings up two important points: "being behind" and correctly building his model. The students were supposed to be at particular points in the activity. The activity consisted of three phases: 1) labeling the parts of the bee; 2) coloring the parts of the bee; and 3) cutting and pasting the parts of the bee together. In phase 1, the teacher told the students how to label the parts of the bee. During phase 2, the students were to accurately color the bee parts. Finally, in phase 3, the students were supposed to cut out and glue the parts together as the teacher instructed, piece by piece. Thus, students were supposed to follow along with the teacher, particularly in phases 1 and 3. Because the students needed to follow the directions of the teacher in order to know how to build the model correctly, they needed to keep up. Thus, Anthony's concerns that he was behind and that there was one right way to build the model were reinforced by the object of the activity and the participation framework.

Similarly, another student, Don, wanted me to tell him if he was building his bee model correctly. He started by asking me if a bee part was on his model correctly [line 355]. Since I was busy helping another student, he turned to a classmate and explained what he thought was correct. His explanation was based on what he thought the teacher

had said. As was evident throughout the activity, the students believed that the teacher and I (another adult authority figure in the room) knew the correct way to build the model. The teacher told the students the parts of the bee, how to color the bee, and how to correctly assemble the model. The teacher and I held the authority and knowledge in this activity and the students deferred to us on how to build the model and the correctness of the model.

In my dialogue with Don, we continued to talk about how to correctly build the bee model. Similar to the students, I was influenced by and reinforced the object of the task and the participation framework. My responses to Don's questions are procedural responses. Instead of asking Don where he thought the various parts of the bee went and why they went in particular places, I resorted to telling him where the body parts should be placed. In line 366, when Don asked where the legs of the bee go, I told him where they should go. Don then questioned my response [line 368], but instead of asking him why he did not think I am correct, I simply signified that I was correct [line 369]. Again, Don questioned my placement [line 370], and I told him why the legs were supposed to go in a particular place on the two dimensional model.[21] Don was one of the few students who questioned where I told him to place particular parts of the bee. It appeared that he was actually trying to figure out where bee parts went and make sense of it, as opposed to more common dialogue that occurred during this activity. Even so, the questions and answers were still centered around where to place particular parts of the bee without regards to the function of the parts of the bee, the characteristics of bees as an insect, or a broader picture of why building a bee model maybe be important.

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[21] Some students had a difficult time figuring out where the various parts went because they were making a two dimensional model, but they were familiar with real bees that were three dimensional insects.

Funds of knowledge and hybrid spaces

The object of the activity and participation framework also had implications for students' abilities to make connections to their funds of knowledge and create hybrid spaces. The task was to build an accurate model. This, combined with the participation framework, left little room for students to draw on their funds of knowledge. The talk during the task focused on correctly labeling, coloring and putting together the bee model. While the students had experiences in their regular lives outside of school with bees (and even inside school) – bees flying around in parks they played in, gardens their family planted, etc., most had probably never thought about the parts of the bee before except that they knew bees have stingers. Some students had been stung by bees before and some were allergic to bees. Many did not like bees because they did not want to be stung by them. The students mentioned some of these experiences during the pre-assessment lesson. But these experiences and knowledge did not help them in this activity and there were not opportunities to students to connect their experiences and knowledge to the model building activity. In other words, the students, teacher, and I did not successfully create hybrid spaces.

Missed opportunities

There was potential in this activity for the students to have meaningful learning opportunities. In the pre-assessment, the students had talked about "what we know" and "what we want to know" about bees. They had learned about plants and flowers and how

bees help pollinate flowers. They had learned about the form and function of the parts of plants, flowers, and seeds. The students had even briefly examined bee specimen. Building a bee model was an opportunity for the students to learn more about bees. They could have learned about the bee parts, their form and function, and how bees were adapted to pollinate flowers.[22] Instead, the activity lacked opportunities for the students to develop conceptual understanding of bees. It turned out to be more like an art activity than a science activity.[23]

These results are similar to what Enyedy and Goldberg (2004) found in their study. One of the teacher's in their study placed emphasis on the product instead of the process or conceptual understanding of the topic. The teacher also used directives and positioned herself in as an authority figure. Furthermore, her assessments evaluated students' progress towards correct completion of the activity. This led to little opportunity for students to gain conceptual understanding of the topic. In similar vein, the bee activity showed the implications that the object of the activity and the participation framework had for student learning. In this case, they provided no opportunities for the students to make connection to their everyday lives and create hybrid spaces and little opportunity for conceptual understanding of bee parts.

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[22] I do not mean this in a Lamarkian sense.

[23] This is not to say that art activities do not contain conceptual understanding and that students are not learning during art activities.

CHAPTER 5

Pond planning activity

Background

During the fall, Ms. Walker talked to the students about doing a project to improve the school grounds. There was a small community grant that classes from Walden school had applied for and received in the past; Ms. Walker wanted to apply for another grant this year. In order to determine what the students wanted to do to improve the school grounds, Ms. Walker took the students on a walk around the school so they could think about what they wanted to do for their project. I was not present during this walk, but Ms. Walker told me that as soon as the class reached the front of the school, the students became very excited.

The school's front doors were lined with two, large, concrete raised boxes that were filled with trees and plants. There was a bird sanctuary area on the left-hand side that another class had created using money from the community grant program the previous year. Ms. Walker's students decided that they wanted to build a pond on the right-hand side. The science specialist at the school worked with a group of five students from the class to research the cost of a flexform pond, a pond pump, and a few plants and write the grant application. The group of students worked on writing the grant application and the entire class signed the application. Happily, the class received the grant money they requested from the local community organization.

The students (at least the small group that worked on it) had already thought about how to create the pond area when they worked on the grant application. They knew that they needed to buy a pond and that they wanted to put plants in the area. In March, I began to work with groups of students to plan more specifically what the pond area was going to look like, how we were going to get all of the materials we needed, and what we needed to do to accomplish the project.

During the first meeting, March 14th, 2007, the students and I went outside to take measurements of the pond area. The pond was going to be placed in a concrete raised box to the right of the school's front doors. At the time, there were three trees planted in a line spaced evenly across the length of the raised box. There were also some small shrubs and plants growing in the box. Ms. Walker wanted the students to measure the area of the box and the distance between the trees in order to determine where to place the pond and the size of the pond. During the second meeting on March 21st, the activity I analyzed in this chapter, a group of students and I talked about the resources that we would need in order to create our pond area. The third meeting took place on March 29th. During this meeting, I worked with students on writing letters to local companies for supply donations.

Chapter overview

In this chapter, I analyze the second meeting with students, the activity that took place on the afternoon of March 21st. I met with Rhonda, Anthony, Evan and Aaron to talk about the pond project. We discussed how we were going to build the pond – what

materials we would need, where we wanted to put the pond, etc. In other words, this was a discussion about the pond design.

This activity differed from the other two activities analyzed. First, it involved a small group of students instead of the entire class. Second, we were not creating a product that would be finished by the end of the activity. Instead, we were having a discussion about how we wanted to build a pond out in front of the school. Third, I played the sole role of the teacher. Ms. Walker was not involved in this activity.

In my analysis, I bring to light how classroom interactions play a large role in what and how students learn during an activity. First, I investigate the object of the activity. I look at how I, as the teacher figure, constructed the task and the task's parameter. Then I examine how I attempted to reinforce and the students negotiated the task and its parameters.

Next, I examine the participation framework. I discuss how the participation framework is established and reinforced throughout the activity. This includes how I positioned the students as designers and holding valuable ideas and knowledge through the use of pronouns. I also demonstrate how my assessments of student talk further positioned the students and I in relation to each other and the task. I show how I position myself as a co-designer and facilitator. In addition, the way that the students build on each other's talk reinforces their position.

Then, I discuss the how the students drew on their funds of knowledge to negotiate and navigate the task. I explore how the students created hybrid spaces, merging their everyday funds of knowledge and school science.

In the conclusion, I summarize the object of the activity and the participation framework. I address how the object of the activity and participation framework work together and shape each other. I reprise how the students drew on their funds of knowledge and how their funds of knowledge were shaped by the task and its parameters. In other words, I discuss how hybrid spaces were created.

Object of the activity

Framing the activity: The task and its parameters

The beginning of the discussion set the stage for the task and its parameters. I had gone around the classroom asking some students to meet me at the table in the back of the classroom so we could do some planning for the pond. From the start of the activity, the students knew that the task was planning how to build the pond. The parameters of the task were not as clear – they emerged as we talked about the pond.

Evan was already talking about the pond as the students gathered at a table in the back of the classroom. He told us about his uncle's pond, which contained Koi fish and how he wanted fish to live in the pond that we were going to build. Since Evan was already talking about the pond when we gathered, I did not have an opportunity to immediately tell the whole group what we were going to do during this activity. After engaging in a brief conversation about the viability of keeping fish in our pond this spring, I attempted to structure the task. I said:

> But what we need to do though is think about... so what do we need to know [Evan interrupts – inaudible] Right? What do we need to know about the pond? Who do we need to, who do we need to talk to about it?

In our planning session, I wanted to figure out how we were going to build the pond – who we were going to talk to, what we resources we needed, etc. While this was the task I set forth, there was constant negotiation from the start about the task and its parameters. The students wanted to not only build a pond, but they wanted to build a pond area where fish and the school turtle could live. From the beginning, the students talked about putting fish in the pond and building a fence for the school turtle so she could live in the pond area. In other words, the students negotiated the task.

The students also negotiated the parameters of the task. In order to build the pond, we needed to work within certain restrictions. We needed to consider our time, money, and material resources limitations. When Evan wanted to have fish live in the pond, I mentioned our time limitations. I did not think we would have enough time to build the pond and give fish time to acclimate to a new environment before the school year ended. When Rhonda introduced the idea of the school turtle, Faster, living in the pond area, I brought up our money and material resources restrictions.

Along with our resources limitations, I asked the students questions about what we would need to do to create a suitable habitat for animals. These questions arose because of the students' desire to build the area as a habitat for animals. This introduced another layer of parameters for the activity. Along with working within our materials limitations to build the pond, we also needed to consider the affordances and constraints of the pond area as a habitat for the school turtle. When Rhonda brought up the school turtle, she said:

> Rhonda: Yeah, we're going to have to put a fence in there so then nobody can go in there, but we can to feed the...

Evan: Fish

Rhonda: and stuff.

Evan: Yeah.

Blakely: So how are we going to make sure Faster doesn't get out though?

Rhonda: We're gonna need a big fence. She can... Because when I used to have Snapper, my other turtle, he used to be in the yard and he just ran away by going through a fence that big and his shell is that big (shows group with her hands how big a hole in the fence was and how big the turtle's shell was).

The primary consideration throughout the activity was determining how to build a fence or barrier to keep the turtle inside the pond area. The students and I considered the benefits and drawbacks of the materials that we could use to build a fence.

Reinforcement and negotiation of the object of the activity

Teacher reinforcement

The task and its parameters were negotiated from the beginning of the activity. As described in the previous section, the students immediately negotiated the task. The students wanted the pond area to be about animals. In other words, the pond area was not just a pond are that would have a pond and some flowers. They wanted the pond area to be a habitat for fish and turtles. I kept trying to draw students away from that idea towards thinking about the basics of putting in a pond (without creating it as a habitat for animals). The following were examples of my attempts.

59 Blakely: We also need to think about cost of this, don't have unlimited money.

.....

105 Blakely: Okay. So, what do we need to do though that we can accomplish by beginning of June? Right? Cause you get out, like, in the beginning of June.

.....

129 Blakely: He knows how to make fences? Okay. Well, let's think about this though. Okay. Do we really want a fence? Is that something that we wanna do and will have time to do by June? Cause we need to be able to build the pond first, right?

130 Rhonda: Yes.

131 Blakely: And we wanna be able to plant different plants around. The plants that you guys are growing. So do you think...

.....

176 Blakely: If we don't have enough time to do it though, right? Cause we, you know, we might barely have enough time to get the pond in. So maybe that's something that we could hold off on a little bit.

.....

284 Blakely: Okay, I know you guys are really wanting to put Faster, um in this little area.

285 Evan: Yeah.

286 Blakely: Which I think is a really great idea. But I'm, I'm just concerned with the basics of getting the pond in right now.

287 Anthony: I know.

288 Blakely: Okay. So can we focus maybe on that? Would that be okay if we focused on actually getting the pond in?

In lines 129-131 and 284-288, I attempted to reinforce that the task was to build a pond, not to build a habitat for animals. In line 59, I brought up money as a limited resource. I talked about time as a limiting resource in lines 105, 129-131, and 176.

Student negotiation

While I kept trying to get the students to consider the basics of building the pond, the students continued to negotiate the task. They kept bringing animals and the pond area as a habitat for animals into the discussion. They also navigated the task's parameters. The students were undeterred by the limitations of the task; they thought of ways around any limitations that I mentioned. When I brought up our time restrictions, the students volunteered to come after school or on the weekends and said that they could ask parents to help out. When I brought up material and money limitations, Anthony offered to contribute $5. The students also thought of free materials that we might be able to use to build a fence. For example, Anthony suggested using old textbooks. We discussed the drawbacks of using textbooks to build the fence (i.e., the paper would decompose). After we eliminated the idea of using textbooks, Anthony thought of another free resource – wood from his old backyard. Aaron also volunteered wood that his dad could cut for us.

At one point, Anthony suggested that we build a dirt barrier around the pond. He thought that the dirt barrier would serve the same purpose as a fence – to keep Faster inside the pond area.

Anthony: Yeah. And when it comes, when the rain comes down it will be tall enough so that when it shrinks, Faster still won't be able to get out. But it will last for a long time. And then we can dig up some more dirt and build it up again.

Blakely: What do you think Evan?

Evan: No, I don't think so. Cause we're going to be leaving in the summer.

Blakely: Mm hm. Okay, what else, what do you guys know? Do you remember when you did earth changes unit at the beginning of the

year too? Do you remember what happens when it...

Rhonda: Rain moves dirt. So we can't use dirt.

Blakely: So if it rains you know and it's, it's making the um, dirt compact, get smaller and shrink. But then what if goes into all water?

Rhonda: Then it'll [inaudible, overlap with Blakely]

Blakely: It could run off and flood the water. Into the water.

Aaron: Then we'd have to clean it.

Anthony: Water, um, we didn't make the hole deep enough for the pond all the way and then the pond all the way and then the pond stick up a little bit and we didn't fill it in all the way... All the way up.

Anthony worked within the parameters of the co-opted task. He did not address the task of how to build a pond that was not a habitat for animals. Creating a habitat for the turtle was central to his (and the other students') ideas about how to build the pond area. Here, he thought of a resource that was readily available and free. He also considered the benefits and drawbacks of using dirt as a barrier. When others raised concerns, he continued to come up additional ideas or reasons for why his idea might work.

Summary of object of the activity

Framing the activity

The task was simply to build a pond. The students negotiated the task; they provided a context for why we should build the pond area, other than to make the area look nicer. They wanted the pond area to be a habitat for fish and the school turtle. I introduced the limitations, or parameters, that we were working under – time, money and material resources - and the students negotiated these limitations. Because the students'

co-opted the task, I also brought up new parameters – considering the affordances and constraints of the pond as a habitat for animals, including the benefits and drawbacks of using different materials for a fence.

Reinforcement and negotiation of the task

I continually tried to reinforce the task. I tried to have the students think about how to build a pond without creating a habitat for the turtle and fish. While I tried to draw them back to the original task, the students pushed the idea of building a habitat for the school turtle. They considered our resource limitations and circumnavigated them by suggesting ways we could create more hours to work on the project and obtain free materials.

Participation Framework

Establishing positioning and power

I positioned the project as **our** project from the beginning of the activity. When Evan started talking about having fish in the pond at the start of the discussion, I tried to direct him away from that idea.

Blakely: Um hm. So, well, actually I don't think **we're** going to have fish this spring. Um, just because given **our** timeline, in terms of, you know, between now and the end of the school year.

Evan: Yeah.

Blakely: It's going to take **our** time just figuring out, like it's still hard out there so **we** can't start digging yet... Um, so in the amount of time

we're gonna actually have to do it and then finally get the pond in.

Even though I tried to guide Evan away from his idea, I told him that I did not think **we** would have enough time. I talked about **our** time and what **we** needed to do. This signified that the students played important roles and served as valuable resources in this project. When I talked about the task, I said:

> Yeah. So, so **we'll** figure it out. **We'll, we'll** do stuff like, you know Evan was saying if **we** need to do it on weekends or if **we need** to come after school **we** would just take volunteers and whoever wanted you know, but no one would be required and stuff like that. Soo um... But **what we need to do** though is think about... so **what do we need to know** [Evan interrupts – inaudible] Right? **What do we need** to know about the pond? **Who do we need to**, who do **we** need to talk to about it?

By talking about the project in terms of **"we"**, I showed that we were designing the pond area together. I was not telling the students how to do it. I provided parameters for the task, but the students had a voice in how we designed the pond. I talked about the task and its parameters in terms of "we" as I brought up things that we needed to talk about and consider. I said, "**We also need to think** about the cost..." and:

> So **we also need to think** about **what can we do** with resources, like money and material, that **we have**? And **if we don't have the resources, if that's what you really want to do, what are we going to do so we can do it?**

Again, I did not tell the students how to build the area. I provided some guidelines and asked them what **we** should do and encouraged the students to think about what **we** wanted to do. I positioned the project as our project where they, with my help, were in charge of designing the area how they wanted. Thus, the students were positioned as designers and I was a co-designer and facilitator.

Reinforcing and negotiating positioning and power

Throughout the activity, I used the pronoun **"we",** which reinforced the students position as designers and my position as their collaborator. **We** were designing and building the pond together. The following are some examples, where I highlight how I positioned the students and myself as the activity continued.

105 Blakely: Okay. So, **what do we need** to do though that **we can accomplish** by beginning of June? Right? Cause you get out, like, in the beginning of June.

.....

129 Blakely: He knows how to make fences? Okay. Well, let's think about this though. Okay. **Do we really** want a fence? **Is that something that we wanna do** and will have time to do by June? Cause **we need to be able** to build the pond first, right?

130 Rhonda: Yes.

131 Blakely: And **we wanna** be able to plant different plants around. The plants that you guys are growing. **So do you think**...

.....

150 Blakely: Mm hm. Okay, what else, **what do you guys know**? **Do you remember when you** did earth changes unit at the beginning of the year too? **Do you remember** what happens when it...

.....

176 Blakely: **If we don't** have enough time to do it though, right? Cause **we**, you know, **we might barely have enough time** to get the pond in. So maybe that's something that **we could hold off** on a little bit.

.....

284 Blakely: Okay, I know you guys are really wanting to put Faster, um in this little area.

285 Evan: Yeah.

286 Blakely: Which I think is a really great idea. But I'm, I'm just concerned with the basics of getting the pond in right now.

287 Anthony: I know.

288 Blakely: Okay. **So can we focus maybe on that**? Would that be okay if **we focused** on actually getting the pond in?

I asked the students to think about how to build the pond. I both asked them to draw on their knowledge and for their ideas and opinions. This showed that I valued their insight and that "they" had ownership over the project. It served to shift some of the power from me as an adult authority figure to the students.

While we talked about what **we** needed to do to build the pond and what **we** needed to think about, there was a constant tension between what the students wanted to do and the limitations that I brought to the students' attention. Thus, there was still an asymmetrical power structure.

Teacher assessments

From the beginning of the activity, my interactions with and responses to the students acknowledged and validated their ideas and helped position them as knowledgeable and having power to make decisions about how to build the pond. Evan began the discussion talking about fish and his uncle's pond. Instead of cutting Evan off and changing the direction of the discussion, I picked up on what Evan was saying.

Table 4

Pond activity coding scheme for analyzing teacher assessment moves

Code	Teacher move
Bold text	Teacher question
Underlined text	Teacher repeating or restating a student response
Italicized text	Teacher building and/or extending a student's response
Bold and italicized text	Teacher question and building and/or extending a student's response

1	Evan:	...but um with the pond, you just take inside and put his Koi fish and silver dollar.
2	Blakely:	**Your uncle has a pond, is that what you said?**
3	Evan:	Yeah, a waterfall pond. There's like a waterfall, then at the bottom there's like a little puddle and the fish live in there, at spring and summer.
4	Blakely:	***Did he make his own or have it built for him?***
5	Evan:	Hmmm. I don't really know.
6	Blakely:	***So what does he do with the fish in the winter?***
7	Evan:	He keeps 'em in a tank inside his house.
8	Blakely:	*So he just takes them out for the winter*
9	Evan:	Yeah...
10	Blakely:	*so they don't freeze.*
11	Evan:	Yeah.

12 Blakely: Okay.

13 Rhonda: And die.

14 Blakely: That wouldn't be good.

15 Evan: So we'd better get a tank in here [classroom] first.
16 Blakely: *Mm hm. So, well, actually I don't think we're going to have fish this spring. Um, just because given our timeline, in terms of, you know, between now and the end of the school year.*

17 Evan: Yeah.

18 Blakely: *It's going to take our time just figuring out, like it's still hard out there so we can't start digging yet... Um, so in the amount of time we're gonna actually have to do it and then finally get the pond in. Um usually you like to do something called acclimate...*

19 Evan: Maybe um.

20 Blakely: *it that like the water and the fish before you can put anything in.*

I asked Evan questions about his uncle's pond and the fish he kept in it, which signified interest and validated what he said [lines 2, 4, 6, 8]. I further validated his responses by asking questions that built on his responses or by simply extending his responses [lines 4, 6, 8, 10]. By building on Evan's talk, I acknowledged that Evan had valuable interests and funds of knowledge that he brought to the project. My responses helped position the students as holding valuable knowledge and ideas that they could contribute to the pond design.

My responses also helped scaffold student thinking about the fish and their interactions with their habitat. Evan mentioned that his uncle kept fish in his pond in the summer and spring. While it may have been obvious why his uncle brought the fish inside during the winter, I probed Evan's thinking about the affordances and constraints

of a small pond as a habitat. I also went on to talk to the students about how fish need time to acclimate to their environment. We co-constructed understanding about fish their interactions with their environment.

I further reinforced the students' position as valuable contributors and designers with my responses to Rhonda and Evan when they suggested that the school turtle was going to live in the pond. I asked them questions about how it would be possible for the turtle to live in the area, which showed that I was interested and validated their ideas and knowledge.

29 Rhonda: Faster's [school turtle] gonna be in the pond.

30 Evan: Yeah.

31 Blakely: Is Faster's going to be in the pond? Who said that?

32 Rhonda: Me.

33 Evan: No, both of us figured out that.

34 Rhonda: Yeah.

35 Anthony: Just a couple of seconds ago you said that.

36 Rhonda: Yeah, we're going to have to put a fence in there so then nobody can go in there, but we can to feed the...

37 Evan: Fish

38 Rhonda: and stuff.

39 Evan: Yeah.

40 Blakely: ***So how are we going to make sure Faster doesn't get out though?***

41 Rhonda: We're gonna need a big fence. She can... Because when I used to have Snapper, my other turtle, he used to be in the yard and he just ran away by going through a fence that big and his shell

is that big (shows group with her hands how big a hole in the fence was and how big the turtle's shell was).

42 Evan: That's strange.

43 Blakely: ***But if we put a fence up though then, how will anyone be able to see into it?***

44 Rhonda: We'll put a short fence...

45 Evan: Oh, good idea.

My questions also built upon and extended their responses [lines 40, 43]. This further acknowledged the students' responses as valid and their ideas as important. They also served to scaffold students' thinking about the affordances and constraints of design. The students also built on each others' talk, which further validated their ideas and provided solidarity. Evan and Rhonda agreed that they both said that Faster should live in the pond area; they both took ownership over the idea. Evan's responses to what Rhonda said in lines 39 and 45 further supported Rhonda's suggestions.

Reinforcing teacher assessments

I continued to encourage the students to come up with ideas for building the pond. I asked them questions about their suggestions and built on their talk to reason about the feasibility of their ideas.

60 Anthony: We can take some old textbooks and make a fence.

61 Blakely: ***Okay, so do you think that would be a good idea?***

62 Students: Noooo.

63 Anthony: Recycle it, like mush them up, like crush them up and all that stuff and make them all together and like put it around the thing

64 Rhonda: Or, or, or we can um, or we can do that and then

65 Aaron: But what happens, what happens to paper when it gets wet?

66 Rhonda: at night we can take Faster inside.

67 Blakely: Mm hmm. Hold on one second. Yeah, what happens when paper decom, ah, gets wet

68 Evan: Soggy

69 Blakely: *and decomposes, right, you know how it decomposes*

70 Evan: The worms will eat it. And the worms will eat it.

71 Blakely: Mm hm. *So paper probably wouldn't be the best idea for a fence.*

When Anthony provided a suggestion for materials to use to build fence, I did not tell him yes or no. I asked the students what they thought about the idea, which showed them that I wanted their input. This reinforced the idea that we were designing and building the pond together. In line 67, I repeated a question that Aaron asked, which served to give it a bigger voice and validate his question. I built on Evan's response to help the students think about the drawbacks of using paper as a building material. During this exchange, the students also built on each other's suggestions [e.g., lines 62, 65], disagreeing each other's ideas, asking questions, and considering potential problems with materials. The interactions all served to reinforce the notion that students' held valuable ideas and knowledge and my role as a facilitator and co-inquirer.

Throughout the discussion, I asked the students questions about their ideas and scaffolded their reasoning about the benefits and drawbacks of using various materials to build a fence for the turtle. The following was another example of a student reasoning about his ideas. This episode came near the end of the discussion.

312 Anthony: I have a cool idea. How about we laminate a bunch of textbooks. But that wouldn't work.

313 Blakely: ***We could. How could we um laminate them?***

314 Anthony: We probably couldn't. That's why I said we probably couldn't.

315 Blakely: Okay.

316 Anthony: There's no laminator that fits like through them.

317 Blakely: To stick the whole textbook through. Okay, so, but we, what you guys had, what you...

318 Anthony: A box, a box.

319 Blakely: ***A box? Would that very good though?***

Here, Anthony already recognized that his idea would not work, even before I got a chance to ask a question. My questions in lines 313 and 319 built on his suggestions, which showed that I valued his idea. They also served to push Anthony's thinking about the affordances and constraints of his ideas. Furthermore, when Anthony told me why his idea would not work I restated it, which validated his thinking. While I cannot make a causal claim, I believe that previous interactions where I helped scaffold the students' thinking about affordances and constraints led to Anthony's reasoning about the affordances and constraints of his idea.

Summary of participation framework

I positioned the students as designers and as holding valuable knowledge and ideas throughout this activity. I used the pronoun **"we"** to talk about what **we** needed to

think about and what **we** needed to do. This gave the students ownership over the project; it showed them that they played an essential role in the designing and building on the pond. It also served to position me as a facilitator and co-designer.

My assessments of the students' talk also showed them that I valued their ideas and opinions. I did not tell them what to do; I provided guidelines. I asked them questions about their ideas, and occasionally repeated or restated and extended what they said, which showed that I valued what they were saying. When I asked the students questions and extended their responses, it also helped scaffold their thinking about the affordances and constraints of their ideas. The students also asked each other questions and built on their ideas, which further validated student ideas and provided solidarity. The interactions between the students and I throughout the activity reinforced the students' position as designers and as holding valuable ideas and my position as a facilitator and co-designer.

Funds of knowledge and hybrid spaces

In this section, I describe how the object of the activity and participation framework created opportunities for the students to draw on their funds of knowledge as they worked through the task.

Making connections to knowledge about animals and habitats

Throughout the discussion, the student brought up their knowledge of animals. Evan drew on his funds of knowledge of his uncle's pond and the practices associated

with caring for fish in it. Evan, Rhonda and the other students drew on their funds of knowledge of the school turtle and its behavior and interactions with its environment. They drew on their funds of knowledge of animals and their habitats to negotiate the task and its parameters. The task was to build a pond. The students decided that they wanted to build a pond that was a habitat for fish and the school turtle. Rhonda suggested building a fence to keep the turtle in the pond area.

Blakely: But if we put a fence up though then, how will anyone be able to see into it.

Rhonda: We'll put a short fence...

Evan: Oh, good idea.

Rhonda: because she doesn't know how to CLIMB.

Blakely: What were you going to say Aaron?

Aaron: I forgot.

Evan: And I think we should put... We should put a certain type of like wood chips, like that.

Rhonda: Yeah, really.

Blakely: You mean around the pond area?

Rhonda: Yeah.

Evan: Yeah.

Rhonda: Because she's going to be walking up and down. She likes wood chips and stuff.

Rhonda drew on her funds of knowledge, her practices taking care of a pet turtle, to think about the type of habitat the turtle would need to have. Rhonda took into account shelter and food – two things that animals need to survive. She reasoned that the turtle needed a

habitat that would keep him safe and knew that the turtle could not climb well. Evan suggested that we put wood chips in the area and Rhonda validated this idea by providing an explanation for the wood chips. The students continually brought their funds of knowledge - their experiences with pets - to bear on the task and talked about animal interactions with their habitats. When we talked about materials to use to build a fence, the students suggested resources that they were familiar with, such as wood from their backyard, old textbooks, or metal from the local, torn down auto factory.

The origin of this task began long before this activity. As described in the *Background* section, the students came up with the idea of building a pond and they helped write a grant to get funding for it. They had ownership over the idea from the start. While they came up with the idea, I could have framed the task in a manner that did not give them ownership or voice on how to design the pond. I could have told them exactly what to do and how to do it. Instead, I asked the students how they wanted to complete the task, within certain parameters. This provided space for the students to draw on their funds of knowledge. When Evan started talking about keeping fish in the pond and Rhonda wanted the school turtle to live there, I did not immediately disregard their ideas. While I attempted to dissuade them, I listened to their ideas and their ideas shaped the task and its parameters.

I positioned the students as designers through how I asked them questions. I asked them how **we** should build the pond. This showed the students that they had valuable ideas to contribute and shifted some of the power from me as an authority figure to the students. It provided space for them to draw on their funds of knowledge. I repeated and extended their ideas and responses, which validated them. The students also

built on each other's ideas, which also validated them. The combination of how the task was framed and the participant framework provided opportunities for the students to draw on their funds of knowledge.

Meaningful learning – Merging funds of knowledge and school science

The students not only drew on their funds of knowledge, but they did so while taking into consideration the task and its parameters. The episode in the previous section showed that Rhonda took into account her knowledge of turtle behavior and its interaction with its habitat as she considered how to complete the task. In the following episode, she and Evan drew on their knowledge of turtle behavior to think about the pond design.

Anthony: Water, um, we didn't make the hole deep enough for the pond all the way and then the pond all the way and then the pond stick up a little bit and we didn't fill it in all the way... All the way up.

Rhonda: That's a great idea!

Anthony: Then Faster wouldn't be able to climb over the edge of it.

Rhonda: Faster really needs to be on land sometimes.

Evan: Yeah.

Rhonda and Evan agreed that the turtle needed to be able to live on land and in water. So creating a barrier around the pond that would not allow the turtle to reach dry land would not provide a suitable habitat for the turtle.

When I brought up constraints such as money and time, the students thought of ways to get around these constraints. For example, Anthony offered to donate some of

his own money if we did not have enough. The students also suggested free materials that we could use to build a fence, such as old textbooks and wood. Aaron said that his step dad might be able to cut down a couple of trees for wood because he cut down trees in the winter for firewood. Rhonda offered to bring the turtle back inside every night if we did not have the materials and money to build a fence. Anthony suggested getting materials from a local auto company that closed down and Evan said that he could check with his dad because his dad worked for that company. The students drew on their funds of knowledge to come up with solutions that would still allow us to build a fence or create the pond as a habitat for the turtle working within our limitations. The students and I created hybrid spaces.

Summary

Throughout this activity, the students brought up funds of knowledge related to fish, turtles, their behavior, and their interactions with their habitats. They drew on their funds of knowledge to co-opt the task and its parameters. While the purpose of the pond activity was not to learn about animals and their interactions with their habitats, this played a central role because of the students' ideas and interests. The students had space to push their interests in part because they were positioned as designers and as having valid ideas and knowledge to contribute to the task. Even as they pushed their agenda, they considered the limitations of our resources and the drawbacks and benefits of using various materials to build the pond area habitat.

Conclusion

Object of the lesson

From its conception, the students had ownership in the pond project. They came up with the idea of building a pond and wrote a grant, with the help of the science specialist. The task of this activity was to figure out how to build the pond. I did not immediately tell the students the task and its parameters, but they knew that we were discussing how to build the pond. I gradually brought up the task's parameters as we talked about how to build the pond.

The students co-opted the task with their focus on building a habitat for animals. While I attempted to dissuade the students from this focus, they kept bringing the conversation back to it and used it as a lens to decide how to build the pond area. When I introduced our time, money, and material resources limitations, the students came up with ideas to get around them. For example, the students countered with suggestions for finding more time to work on the project and free resources that we could use. Finally, because the students' co-opted the task, we also considered the benefits and drawbacks of using different materials for building a fence or barrier for the turtle's habitat.

Participation framework: Positioning and power

In this activity, I positioned the students as having valuable knowledge and ideas to contribute. I talked about what **we** needed to think about in order to complete the task and what **we** needed to do. This positioned the students as designers and positioned me as a co-designer.

My responses to student talk also showed the students that they had good ideas and valuable knowledge. I asked them questions about what they wanted to do, restated, and built on their responses. This served to validate their ideas and also scaffolded their thinking about our resource limitations and the benefits and drawbacks of using different materials to build the pond area. I acted as a facilitator. The students also validated each other's ideas, which served to built solidarity.

Interrelatedness of object of task and participation framework

The participation framework influenced the task and its parameters. The positioning of the students as designers and my responses to them, such as picking up on their ideas and validating them provided the students with space to negotiate the task and its parameters. My responses to students also scaffolded their thinking about the affordances and constraints of their ideas. The framing of the task also influenced the participation framework. In the task, the students and I were working together to figure out how to build the pond. Since we were figuring it out together, I asked the students questions about how they thought we should build the pond. Thus, while I separated the object of the activity and the participation framework in my analyses, they are entwined.

Funds of knowledge and hybrid spaces

The object of the activity and the participation framework created space for the students to draw on their funds of knowledge. The students drew on their funds of knowledge to help them think about resources to use and what the turtle would need to

make the pond area a viable habitat for it. Furthermore, my positioning of the students as designers provided students with the opportunities to draw on their funds of knowledge and negotiate the task and its parameters. My responses to student talk also encouraged them to continue to draw on their funds of knowledge. I asked them questions to shape their thinking and often tried to steer students away from some of their ideas, but I still validated their knowledge and ideas by asking questions and building on what they said. The students drew on their funds of knowledge to negotiated the task and its parameters. They worked within the material constraints of money, time, and material resources. They also considered the affordances and constraints of the pond as a habitat for fish and the turtle and reasoned about materials to use to build a fence. Thus, the students drew on their funds of knowledge to help them think about the task at hand. In other words, they created hybrid spaces.

CHAPTER 6

Conclusions and Implications

Overview

There are various factors that influence interactions within a setting. Erickson (2004b) states, "Economy, history, and the distribution of power within society provide what we do in face-to-face interaction with sets of constraints and enablements which we encounter as structures of local affordance" (p. 16). He goes on to explain that, "All constraints, because they define boundaries, also provide enablements" (p. 17). This does not imply a deterministic point of view. Erickson simply points out that contextual factors on a larger scale shape interactions that occur on smaller scales. The same is true of how students interact in microcosms of society in school settings. In a classroom (or outside of a classroom), each science activity provides constraints and enablements in terms of what is learned and how it is learned. There are expectations for the products students produce, how they produce them, and the type of student and teacher interactions that occur during the activity.

I began this study with the aims of investigating how students' make connections between their everyday lives and school science. I brought a sociocultural perspective of learning to bear on my research. I applied the view of learning as entering into a community of practice, in this case the community was the community established in an activity, to analyze three activities in a 4th grade class. I examined how the affordances and constraints of three activities shaped students' opportunities to learn. In particular, I studied how the activities provided space for students to draw on their funds of

knowledge and create hybrid spaces. In order to investigate this, I focused on 1) the object of the activity and 2) the participation framework. The object of the activity consisted of the task and its parameters. I looked at how the teacher framed the task and its parameters and how it was negotiated and reinforced throughout the activity through student and teacher interactions.[24] In order to investigate the participation framework, I examined the teacher's use of pronouns and directives to see how she established and maintained teacher and student positioning in the activities. I also analyzed how the teacher responded to student talk. I called this teacher assessment. The teacher assessments also contributed to the positioning of the teacher and students, and thus the distribution of power in the activity. The sum of these components made up the participation framework. The analysis of the object of the activity and the participation framework provided opportunities to show how the students and teacher drew on their funds of knowledge.

In this chapter, I will summarize the findings from each of the results chapters. Then, I will discuss four themes that arose from looking across the findings chapters and their implications for teaching and learning. Finally, I discuss the limitations of this study.

[24] I include myself as a teacher along with Ms. Walker because I usually played the role of a teacher in activities.

Chapter 3: Bird activity

Object of the activity and participation framework

In the bird activity, the students were asked to create a bird; the final product was a bird made out of construction paper. As they created their bird, the students were expected to consider the form and function of bird adaptations and how they aided its survival in its ecosystem. Ms. Walker positioned the students as knowledgeable designers and herself as a facilitator. She asked to create *their* own bird. Ms. Walker asked them questions about the form and function of bird parts that she wanted the students to include. This positioned the students as knowledgeable designers and scaffolded their thinking about the form and function of bird adaptations. She also built on students' ideas, often restating or repeating and expanding on them. Restating or repeating students' ideas validated them. Furthermore, when Ms. Walker expanded on their ideas, she scaffolded their reasoning about form and function. Thus, her teacher assessments established the students as knowledgeable designers and herself as a facilitator. Interactions between the teacher, students, and I reinforced the object of the task and participation framework throughout the activity.

The object of the task and the participation framework also supported each other. For example, the task was for the students to design their own bird. Thus, the students were positioned as designers due to the nature of the task. When the teacher and I scaffolded student reasoning about the form and function of adaptations, we also strengthened the object of the activity.

Funds of knowledge and hybrid spaces

The object of the activity and participation framework provided affordances and constraints for how students drew on their funds of knowledge. For example, the task presented students with opportunities to draw on their funds of knowledge. The students had experiences with birds and ecosystems in their everyday lives, whether it was seeing birds flying in the sky, reading about them, or seeing them in movies. The parameters of the task and the participation framework allowed the students to make connections to their funds of knowledge and shape those funds of knowledge into a better understanding of bird adaptations. The teacher and I helped the students think about the form and function of familiar bird characteristics. Together, we considered how adaptations helped birds survive in different types of ecosystems.

Furthermore, the students were positioned as knowledgeable designers. The teacher and I built on the students' funds of knowledge to help them think about the design of their bird in scientific ways. Through interactions between the teacher, students, and I, the students saw that their knowledge was an important resource for this activity. The students used their funds of knowledge to help them complete the task. Some students even drew on their funds of knowledge to negotiate the task's parameters, such as what counts as an ecosystem and adaptation.

Chapter 4: Bee model activity

Object of the activity and participation framework

In the bee activity, the students were asked to build a model of a bee. They were provided with two pieces of paper that contained the outlines of bee parts. The students followed Ms. Walker's instructions to build an accurate bee model. Ms. Walker told them how to label, color, and cut and paste the bee parts. There was no successful student negotiation of the object of the activity. Ms. Walker used directives to give the students instructions, which positioned the students as passive participants and herself as the authority figure. She rarely asked the students questions. The students reinforced Ms. Walker's position as the authority figure through their questions. They asked her if they were completing the task correctly. I was also an authority figure in this activity. The students asked me how to correctly complete the task and I told them how they should complete it. Ms. Walker and I did not scaffold the students' thinking about the construction of the bee model. We told them how to do it and evaluated how well the students were completing the task, which further supported our position as authority figures and the students' position as passive receivers.

The object of the activity and participation framework were intertwined. For example, the task was to build an accurate bee model. Ms. Walker used directives to instruct the students in how to build an accurate bee model, which supported the task and positioned her as an authority figure. The teacher assessments, telling the students if they were building their model correctly, also positioned Ms. Walker as an authority figure with the correct answers and reinforced the task. The object of the activity and the

participation framework offered limited opportunities for the students to learn about bees. They may have learned about the form of a bee, but they did not learn the function of bee parts, the characteristics of bees as an insect, or gain a broader understanding of why building a bee model was important.

Funds of knowledge and hybrid spaces

The object of the activity and the participation framework provided limited opportunities for the students to draw on their funds of knowledge. The task was to build a bee model. The students had some knowledge of bees. Some students knew that there were different types of bees (queen bee, worker bee, drone bee). Many had been stung by bees, knew that bees lived in hives and that they made honey. But the students' funds of knowledge did not help them create an accurate bee model. Thus, the task provided few occasions for the students to draw on their funds of knowledge.

Furthermore, the students were supposed to follow Ms. Walker's step-by-step instructions to complete the task. This also restricted students' chances to make connections to their funds of knowledge. When students did tell make connections, the connections did not help the complete the task or increase their understanding of bee parts. In this activity, the students were not able to merge their funds of knowledge with the school science activity. In other words, no hybrid spaces were created.

Chapter 5: Pond activity

Object of the activity and participation framework

In the pond discussion, the task was to figure out how to build a pond and we had to take into account our time, money, and material resources in our design. The students began the discussion by talking about creating a pond that was a habitat for animals; the students co-opted the task. Since the students immediately co-opted the task, the parameters of the task also changed. We not only considered our time, money, and materials resources for building the pond, we also discussed the benefits and drawbacks of using various building materials for a fence for the turtle's habitat.

In this activity, I positioned the students as having valuable ideas and knowledge. I asked them what *we* needed to think about and what *we* needed to do to build the pond. This positioned the students as knowledgeable, gave them ownership over the task, and positioned me as a co-designer. My responses to students also showed the students that I valued their knowledge and ideas. Similar to the teacher assessments in the bird activity, I built on students' ideas and used them to scaffold their reasoning about our resource limitations and the benefits and drawbacks of using various materials to build the turtle's habitat. The students also built on each other's ideas and knowledge, which further positioned them as knowledgeable and built solidarity.

The object of the task and the participation framework formed a reflexive relationship. The participation framework provided the students with opportunities to negotiate the object of the activity. The students' position as designers and my responses to their ideas provided space for students to co-opt the task and negotiate its parameters. My responses to student talk also reinforced the task and its parameters, helping them

consider our resource constraints and the benefits and drawbacks of building materials. In addition, the nature of the task influenced the participation framework. We needed to determine how to build a pond. I did not know how to build a pond. I knew the constraints that we were working within and I worked with the students to try to figure it out.

Funds of knowledge and hybrid spaces

In the pond activity, the object of the task and the participation framework provided opportunities for students to draw on their funds of knowledge. The students drew on their funds of knowledge to co-opt the task. From various experiences such as caring for pets, they knew that fish and turtles lived in habitats like the one we were creating. They used their funds of knowledge to think about what we would need to include in the area to make sure it was habitable for the school turtle (i.e., wood chips, water, materials for a fence). Students not only made connections to their funds of knowledge, but we reshaped them as we engaged in the task. We built on students' funds of knowledge; we considered the benefits and drawbacks of ideas based on our resource constraints and knowledge of turtle habitats. The participation framework - our positions and how we interacted, validated, and reasoned about ideas - supported the merging of funds of knowledge and school science.

Themes and Implications for Teaching and Learning

The three activities provided different types of opportunities for the students to draw on their funds of knowledge. I was interested in the affordances and constraints that activities provided in terms of students opportunities to draw on their funds of knowledge. More importantly, I was interested in how the students and teachers drew on students' funds of knowledge in productive ways that built on students' funds of knowledge to create deeper understanding of science concepts. In the summaries of each activity above, I summarized how the object of the activity and the participation framework created opportunities for students to draw on their funds of knowledge and develop hybrid spaces.

In this section, I highlight four themes and implications for teaching and learning. First, I discuss the importance of connecting school science and students' everyday lives. In the next two sub-sections, I discuss two key aspects that are central to developing hybrid spaces: shifting power and authority and scaffolding student thinking. Finally, I argue for the importance of co-constructing knowledge.

Importance of making connections to everyday lives: Funds of knowledge and hybrid spaces

A central premise of the funds of knowledge work is that students hold much knowledge (embedded in practices) from their everyday lives that is valuable and should be leveraged in school learning (Gonzalez, Moll, & Amanti, 2005; E. B. Moje, Collazo, Carrillo, & Marx, 2001; Moll, Amanti, Neff, & Gonzalez, 1992). There is also an assumption and some evidence that making connections to students' everyday lives will

lead to better quality instruction (Calabrese Barton & Tan, in preparation; Heath, 1983; C. D. Lee, 2001; E. B. Moje, Collazo, Carrillo, & Marx, 2001). In order for connections to create better quality science instruction, I argue that students must not only make connections to their funds of knowledge, but they need to build on them in scientific ways. Cazden (2001) points out:

> ... a pervasive teaching dilemma: How to validate a student's present meaning, often grounded in personal experience while leading the child into additional meanings, and additional ways with words for expressing them that reflect more public and educated forms of knowledge. (p. 22)

Teachers are called on to help students extend their understanding of scientific concepts and ways of thinking. In her ethnography, Shirley Brice Health studied how teachers successfully drew on students funds of knowledge to create quality instruction. The teachers' goals were (Heath, 1983, p. 340):

(1) to provide a foundation of familiar knowledge to serve as context for classroom information;

(2) to engage students in collecting and analyzing familiar ways of knowing and translating these into scientific or school-accepted labels concepts, and generalizations; and

(3) to provide students with meaningful opportunities to learn ways of talking about using language to organize and express information.

Carol Lee drew on similar goals in her Cultural Modeling Project (C. D. Lee, 2001, 2006). In her work, she used text students were familiar with and had knowledge of the

social codes operating in the text and used them to help students develop skills for reading canonical literature.

In this study, I found that aspects of Heath's goals were necessary in order for students and teachers to create hybrid spaces. The bird and the pond activities met the first two goals. First, the students were able to draw on their knowledge of birds, fish, turtles, and ecosystems and use this as a foundation for the classroom activities. Second, the teacher and I scaffolded the students' thinking about form and function; we helped them reason in a scientific way about adaptations and animal interactions with their habitats. While we did not discuss the language that we were using to talk about adaptations (goal 3 – meta-level thinking about language), we scaffolded their reasoning and talk by restating and extending their ideas. In the bee activity, one of the three goals may have been partially met. The students had prior knowledge about bees and the teacher provided activities to ascertain this knowledge. But this knowledge was not leveraged to help them complete the bee model. The students did not translate their experiences with bees into scientific ways of knowing and thinking about the form of bees. Thus, the students and teacher were not able to create hybrid spaces.

In the next two subsections, I will unpack how teachers can help students make connections to their funds of knowledge and create hybrid spaces through shifting the power and authority in the classroom and scaffolding students' thinking.

The role of the object of the activity and the participation framework in shifting power and authority

In much of Moll and his colleague's work (Gonzalez, Moll, & Amanti, 2005; Moll, Amanti, Neff, & Gonzalez, 1992), teachers investigated students' funds of knowledge through interviews about family household practices and used them as a basis for curriculum development. Many teachers do not have the freedom (due to mandated curriculum) or time to do this. So how can teachers draw on funds of knowledge using existing resources and/or without conducting family interviews?

The teacher must create space for the students to make connections to their funds of knowledge. In order to do this, the teacher needs to change the power dynamics in an activity. The teacher is the default authority figure in a classroom. The teacher usually determines the learning objectives of lessons and units and often decides the route the students take to meet the learning objective. In other words, the teacher chooses the object of the activity. The teacher, through her actions, can distribute some of her power and authority to the students, thereby creating space for students to make connections to their funds of knowledge. This can occur through the framing of the object of the lesson and the participation framework.

Through examining the object of the activity and the participation framework, I found that when the students were positioned as knowledgeable designers, they made connections to their funds of knowledge. In the bird activity, the students were asked to create their own bird. They worked within certain parameters, but they were able to draw on their funds of knowledge to design their bird because they were positioned as designers by the task and through the participation framework. The teacher asked the

students questions about how they wanted to build their bird and built on their responses. Similarly, in the pond activity the students were positioned as designers. In my analysis, I showed how this positioning was established and reinforced through the task and the participation framework. Thus, in both activities the power shifted from the teacher to the students. In the bee activity, the students were positioned as passive receivers and they rarely brought up funds of knowledge related to bees. When they did, the funds of knowledge did not help the students complete the task.

Other research supports the idea that shifts in power need to occur in order for hybrid spaces to develop. For example, Calabrese Barton and Tan (in preparation) found that in the classroom's hybrid spaces, the teacher positioned himself as a facilitator instead of an authority figure and the students gained more authority. Crawford, Kelly, and Brown (2000) also discussed the importance of the teacher and students' positions. In their study, the teacher positioned herself as a co-investigator and the students in decision-making roles. Their positions provided the students with opportunities to explore their questions in scientific ways and the teacher and students worked together to co-construct scientific understanding.

Scaffolding student thinking – Merging funds of knowledge and school science

Moje and her colleagues (2004) offered three theories of third space: third space as a bridge between community and home-based Discourses to school-based Discourses; navigational space between community and home-based Discourses to school-based Discourses; and transformative space where Discourses merged and created new

Discourses. Ideally, third or hybrid spaces that are created in activities encompass all three of these theories.

Hybrid spaces are not created when students simply make connections between their funds of knowledge and a school science activity. For example, in the bee activity a few students brought up their funds of knowledge but their funds of knowledge did not help them complete the activity, nor did it help them make connections between inside and outside of school Discourses or transform their knowledge and Discourses. Furthermore, asking students about their experiences without connecting it to the object of the activity or building on it to create a deeper understanding of content and practices does not constitute a hybrid space.

So how are hybrid spaces created and what do they look like? The teacher plays a central role in helping the students merge their funds of knowledge and school science. As students are learning to enter into a community of practice, the teacher must help the students build on their funds of knowledge. In the bird activity, the teacher built on students funds of knowledge and helped scaffold their thinking about the form and function of bird parts. She did this through the participation framework. She encouraged the students to draw on their funds of knowledge, repeated or restated students' ideas, and extended them to explain how adaptations provide particular affordances and constraints for birds. Thus, the students were forming a bridge, navigational space, and transforming their understanding of birds to gain a deeper understanding of adaptations and birds' interactions with their ecosystems.

In the pond activity, the students drew on their funds of knowledge to co-opt the task and to think about material resources we could use to build the pond. I helped the

students think about the design of the pond within our resource constraints; I scaffolded their thinking about the benefits and drawbacks of building materials and the pond as a habitat for fish and the school turtle. In this activity, the students also began to scaffold each others' understanding of affordances and constraints of materials and animal habitats.

Thus, the teacher must consider the scaffolding process that occurs as she and the students build on students funds of knowledge to develop a deeper understanding of scientific concepts and practices.

Co-constructing knowledge

A fourth theme arose from the data: the co-construction of knowledge and understanding. The co-construction of knowledge and understanding is inextricably linked to the previous themes. In the bird and pond activities, the teacher and students co-constructed their knowledge of animal adaptations as they completed the tasks. The teacher, building on students' knowledge and ideas, helped scaffold their reasoning. In their study, Cobb and his colleagues (1992) found that when learning was co-constructed, the students and teacher developed a shared understanding of mathematical reasoning and concepts. They also asserted that procedural pedagogy, where the teacher provided procedural instructions for the task, served to delegitimize students' ideas and created the understanding that, in this case arithmetic, involves following procedures instead of conceptual understanding. Along a similar vein, Wells and Arauz (2006) noted the value of dialogic interactions. They discussed how dialogic interactions, as opposed to

monologic ones, serve to include alternative perspectives and leads to a greater understanding of the topic discussed. Hogan and Corey (2001) stated:

> Through open, mindful dialogue with students we can gain insight into their cultural and epistemological perspectives, then work toward creating learning situations that give them access to tools of a specialized community of practice, while respecting the vitality and priorities that they bring to the cross-cultural exchange. (p. 239)

In the bee activity, the teacher used a procedural pedagogy that deligitimized students funds of knowledge. The teacher and students did not co-construct conceptual understanding of bee parts, the form and function of bee parts, or how bees help pollinate flowers. In the bee activity, the students were socialized into a community of practice where the valued practice was following the teacher's instructions instead of gaining a deeper understanding of bees.

Limitations of the Study

As Geertz (1973) stated, "Cultural analysis is intrinsically incomplete. And, worse than that, the more deeply it goes the less complete it is" (p. 29). Teaching and learning are complex processes and there are many factors that influence a learning environment. I used activity as a unit of analysis to examine how two aspects of an activity: the object of the activity and the participation framework provided affordances and constraints for student learning. However, there are many other factors that influence learning. For example, the teacher's content knowledge may have played a role in how

she framed the object of the activity in the bee activity and interacted with the students. Factors such as time limitation also may have played a role; Ms. Walker may have used a procedural approach because time was a factor. Furthermore, perhaps using a procedural approach was the most appropriate pedagogy for the bee activity. The students had little prior knowledge of bees and their form and their funds of knowledge related to bees were not relevant to this task.

This raises another limitation of this study. I analyzed three activities. I did not analyze the activities of a specific unit and look at students' opportunities to learn across the unit. Within a unit or even one lesson, there are multiple activities with various objects of activities. The students may participate in some activities where they conduct investigations. In these investigations, they may collect and analyze data and form theories. In other activities, the students may follow the teacher's instructions to complete the task. For example, during the plant unit the students learn how to grow hydroponics. In many of these lessons, the teacher used a procedural pedagogy, such as when she used directives to tell the students how to stake the plants when they grew tall and were at risk of falling over. When the students transplanted plants, she also used a procedural pedagogy to instruct them. In the bee activity the use of a procedural pedagogy may have been the most appropriate for the learning objectives.

I applied certain lenses to my study. I do not doubt that others would have found different aspects of the data interested, applied different lenses to the data and generated different findings. As Bogdan and Biklen (1992) state:

> For it is social values and ways of making sense of the world that can influence which processes, activities, events, and perspectives researchers consider

important enough to code. Different theoretical perspectives that researchers hold shape how they approach, consider, and make sense out of the data." (pp. 172, 175)

For example, I could have applied an identity lenses to this study to investigate how students' identities were shaped across the different activities. Students' identities may have played a role in how students engaged in the activities and what they learned. I initially thought that I might be able to trace individual students' participation across activities. Unfortunately, due to the nature of my data, I was unable to do that. While I described how aspects of the activities provided opportunities for students to learn in general, individual students may have engaged differently in different activities. Thus, it would be interesting to see how the object of the activity and the participation framework affect individual students' participation in different activities.

Concluding Remarks

In this study, I attempted to ascertain how students' made connections between their everyday lives and school science. But as Geertz says, "Cultural analysis is (or should be) guessing at meanings, assessing the guesses, not discovering the Continent of Meaning and mapping out its bodiless landscape" (Geertz, 1973, p. 20). This study shed light on some aspects of teaching and learning, but more work needs to be done to understand the funds of knowledge that students bring into the classroom and how hybrid spaces are developed. We need to unpack how students learn to participate in and become competent members of science learning communities. It is especially important

that we learn how to make connections between students' funds of knowledge and school science if we want students to see the importance of science in their everyday lives and use science in their everyday lives.

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