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From "Sit and Listen" of "Shake It Out Yourself" : Helping Urban Middle School Students to Bridge Personal Knowledge to Scientific Knowledge through a Collaborative Environmental Justice Curriculum

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FROM "SIT AND LISTEN" TO "SHAKE IT OUT YOURSELF": HELPING URBAN MIDDLE SCHOOL STUDENTS TO BRIDGE PERSONAL KNOWLEDGE TO SCIENTIFIC KNOWLEDGE THROUGH A COLLABORATIVE ENVIRONMENTAL JUSTICE CURRICULUM

by

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ABSTRACT

An abstract of the dissertation of Shamu Fenyvesi Sadeh for the Doctor of Education in Educational Leadership: Curriculum and Instruction presented May 8, 2006.

Title: From "Sit and Listen" to "Shake It Out Yourself": Helping Urban Middle School Students to Bridge Personal Knowledge to Scientific Knowledge Through a Collaborative Environmental Justice Curriculum

Science education and environmental education are not meeting the needs of marginalized communities such as urban, minority, and poor communities (Seiler, 2001; U.S. Environmental Protection Agency [EPA], 1996). There exists an equity gap characterized by the racial and socioeconomic disparities in: levels of participation in scientific and environmental careers and environmental organizations (Lewis & James, 1995; Sheppard, 1995), access to appropriate environmental education programs (U.S. EPA, 1996), exposure to environmental toxins (Bullard, 1993), access to environmental amenities and legal protections (Bullard, 1993), and in grades and standardized test scores in K-12 science (Jencks & Phillips, 1998; Johnston & Viadero, 2000). Researchers point to the cultural

divide between home and school culture as one of the reasons for the equity gap in science education (Barton, 2003; Delpit, 1995; Seiler, 2001).

This study is designed to address the equity gap by helping students connect personal/cultural knowledge to scientific knowledge. A collaborative action research study was conducted in 8th-grade science classrooms of low-income African American and Latino students. The participating teacher and the researcher developed, enacted and evaluated a curriculum that elicited students' personal and cultural knowledge in the investigation of local community issues. Using qualitative methods, data were collected through student and teacher interviews, observation, and written documents. Data were analyzed to answer questions on student participation and learning, bridging between personal and scientific knowledge, and student empowerment. The most compelling themes from the data were described as parts of three stories: tensions between the empire of school and the small student nation, bridging between the two nations, and students gaining empowerment.

This study found that the bridging the curriculum intended was successful in that many students brought personal knowledge to class and started to bring scientific knowledge into their personal worlds. Students translated between scientific language and their own language, displayed an understanding of community environmental health issues, and expressed a sense of empowerment as students and community members. Recommendations to science educators and

researchers included: eliciting students' personal and cultural knowledge in the classroom, helping students to create new ways of participating in science, and engaging in collaborative research efforts.

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CHAPTER I

INTRODUCTION

I was drawn to this research because of my experience as a student in urban public schools that were failing the mostly African American students and my belief that schools are places where we can start to right the wrongs of society. I saw the work being done on the achievement gap as part of an effort to understand the inequalities in the classroom and generate solutions. Additionally, I saw the potential for science and environmental education to be tools for empowerment for the individual student, the classroom, and the community.

I spent almost two years in a school I call Columbia Middle School (a pseudonym), a school populated mostly by low-income African American and Latino students. In the science classroom, I divided my time between listening to students and teachers, and trying to instigate changes. I wanted to get the students excited about science, and I wanted to help them to develop a sense of agency and an awareness that each one of us can bring about positive social change.

Listening to the students I learned of the wide gulf between their own world, their language, their ways of knowing, and the world of the teachers, textbooks, and classrooms. I heard in their comments an insistence that they deserved more respect than they received; an insistence that they be given active

and important roles in their learning. In some of the activities of the curriculum I developed with the participating teacher, I was able to observe how eager many students were to use their new scientific knowledge and to express themselves as experts and activists.

This dissertation tells the story of tensions between what I call the small student nation and the empire of school. It tells the story of an effort to build a bridge between these two nations and to create mutual respect and understanding. Finally, this dissertation tells the story of students gaining agency and constructing new ways of being science students, new ways of thinking about their role in their community.

This study follows the tradition of exploring the clash in the classroom as a clash of cultures (Delpit, 1995; Ogbu, 1978), and individuals striving for respect (Kohl, 1994; Tobin, 2000). I align my work with research that looks at education as a tool for personal and community empowerment (Barton, 2003; Freire, 1998; Roth & Desautels, 2002). This study contributes to the growing literature on race, culture, and science learning by offering a detailed exploration of students' views, and by exposing the tensions and possibilities in bridging science learning and the students' world, bridging "data collection" and "shake it out yourself."

I use the students' own words in this dissertation for several reasons. Bridging the equity gap involves better understanding those standing on the other side of the gap. I use students' words as part of my effort to reach across the gap into the student nation. I also felt that I could better describe students' ideas to the

reader in the students' language. Finally, in this study I helped students to learn scientific language, and they helped me to learn their language. I asked students to use scientific words in their assignments, presentations, and even in their conversations with friends. Using students' language in my dissertation reflects the ethic of reciprocity upon which this study is based.

When students at the middle school spoke of what they saw as passive, rote, and irrelevant school learning, they called it "sit and listen." When we asked students how we should investigate science issues in the community, one student quickly suggested, "You can shake it out yourself." In reading this dissertation, rather than telling you, the reader, to "sit and listen," I encourage you to "shake it out yourself."

The Equity Gap

The purpose of this study is to address the equity gap. Science education and environmental education are not meeting the needs of marginalized communities such as urban, minority, and poor communities (Seiler, 2001; U.S. Environmental Protection Agency [EPA], 1996). The equity gap is characterized by the disparities in students' race and socioeconomic status in:

- levels of participation in scientific and environmental careers and environmental organizations (Lewis & James, 1995; Sheppard, 1995)
- exposure to environmental toxins (Bullard, 1993)
- access to environmental amenities such as greenspaces and legal protections (Bullard, 1993)

- access to appropriate environmental education programs (U.S. EPA, 1996)
- grades and standardized test scores in K-12 science, what is commonly called "the achievement gap" (Jencks & Phillips, 1998; Johnston & Viadero, 2000).

The Achievement Gap

The achievement gap may be understood in terms of the differences between high socioeconomic status (SES) European American students and poor, urban, and minority students' performance and participation in, and access to, science as expressed by the following: test scores and grades in K-12 (Jencks & Phillips, 1998; Johnston & Viadero, 2000), access to higher-level science classes (Oakes, Gamoran & Page, 1992), adequate equipment and certified science teachers (Ingersoll, 1999; Oakes, 1990), and opportunities to participate in science and to see themselves as possible members of the scientific community (Dickerson, Bernhardt, Brownstein, Copley, & McNichols, 1995).

For example, Jencks and Phillips (1998) write, "the typical American black still scores below 75% of American whites on most standardized tests" (p. 1). At Columbia Middle School, the setting for the pilot and dissertation research, in 2002-2003, 71% of African American and 84% of Hispanic students did not meet standards for statewide assessments in reading, compared to 44% of White students. In Mathematics, 67% of African American, 76% of Latino and 38% of White students did not meet state standards. The parallel data in statewide science assessments are currently unavailable.

There are some aspects of the so-called achievement gap that are problematic. Standardized tests are a limited measure of achievement, and the gaps in test scores have been used to support negative stereotypes about the abilities of racial and cultural groups. Additionally, at Columbia Middle School I found that the school policies surrounding the achievement gap ended up punishing rather than supporting the teachers and students. For example, the administration increased their oversight into teachers' curricular decisions, and according to the collaborating teachers, created an atmosphere of competition over students' test scores that divided the teachers.

Researchers have critiqued the validity of standardized tests (Jencks & Phillips, 1998) and raised questions of bias (Schellenberg, 2004). Traditional forms of student assessment, such as multiple-choice tests, may miss diverse forms of cultural knowledge (Smith-Maddox, 1998). Additionally contextual issues of how students are prepared for the tests, and how tests are administered may impact students' scores (Haladyna, Nolen, & Hass, 1991).

Furthermore, researchers such as Barton (1998, 2003), Delpit (1995), and Seiler (2001) argue that the language of the achievement gap labels children as deficient and holds them responsible for those deficiencies. The central assumption embedded in the concept of the achievement gap – and in the subsequent proposals to correct the gap – is based on what Delpit and Barton (2003) refer to as "the deficit model" (Delpit, 1995, p. 26). The deficit model focuses on what certain groups of students (African American, Latino, poor) lack – not on what they

possess. In such an approach, solutions to close the achievement gap are based on changes that these students need to adopt; substantive changes to the way science is taught are rarely considered.

There is a bias in this approach that Barton (1998, 2003) and Seiler (2001) argue must be reversed in order to foster a truly inclusive science education. Later in this dissertation I discuss examples of approaches to science education with marginalized students that offer an alternative to the deficit model.

I use the framework of the equity gap because I believe that the achievement gap describes only a small piece of the many interconnected racial and socioeconomic inequities. These inequities include environmental justice and the poverty of diverse voices within science education and environmental education.

Environmental Justice and Marginalized Voices in Science Education and Environmental Education

During the pilot study, I asked a class of eighth graders at Columbia Middle School how many of them or their families suffered from asthma; 24 out of 27 students raised their hands. I believe that engaging marginalized, urban science students in the exploration of environmental issues in their neighborhoods offers great potential to foster learning and engagement in school science, and at the same time, further environmental justice. Clearly, issues such as diesel pollution and asthma are relevant to these communities (Podobnik, 2002).

In his groundbreaking work on environmental racism, Bullard (1993) provides evidence that African American, Latino, and Native American

communities receive more exposure to environmental toxins, less protection from government agencies, and enjoy fewer environmental amenities such as greenspaces. For example, highly polluting industries such as chemical industries or garbage incinerators are placed in African American communities in disproportion to neighboring European heritage communities. Urban minority neighborhoods often lack access to natural areas compared to Euro-heritage neighborhoods (Westra & Wenz, 1995). According to Bullard, environmental justice is built on a redressing of existing inequities, equal sharing of our society's environmental burdens, equal rights to environmental protection, and equal access to clean air, water, and soil.

However, issues of environmental justice have only recently been seen as worthy of study and response by educators and activists (Taylor, 1996). The environmental movement in the U.S. has been criticized for its European American upper-middle class bias (Carl, 1996; Running-Grass, 1996). Hargrove (1995) argues that environmentalists' negative bias against urban areas is entangled in racial bias.

Similarly, scholars charge that science education and environmental education programs do not reflect the voices of marginalized communities (Barton, 1998; Lewis & James, 1995). Poor, Latino, and African American communities have lower levels of participation in environmental organizations (Sheppard, 1995) and in environmental and scientific careers (Lewis & James, 1995). Researchers argue that students from these communities have fewer opportunities to participate

in school science than their higher SES European American peers (Dickerson et al., 1995; Rodriguez, 1998). I characterize this combination of inequities in environmental conditions, in access to and participation in education, in test scores and grades, as the equity gap in science education and environmental education.

Some Reasons for the Equity Gap

Recently scholars have suggested a number of factors responsible for the equity gap in science education and environmental education. These explanations of the equity gap are not meant to represent a complete list, but rather to offer a theoretical and practical foundation for my study on science education for marginalized students.

A cultural bias within science education and environmental education prevents minority voices from being heard and widens the divide between home culture and the culture of school science for minority and low-income students (Barton, 2003; Taylor, 1996). The reliance by educators on curriculum and pedagogy that do not appreciate the students' knowledge and interests and are not relevant to these underserved communities fails to engage students (Delpit, 1995; Wals, 1994). Finally, research that relies on a detached researcher, teachers, and students as subjects (Rickinson, 2001), the hierarchy of theory over practice (Carr & Kemmis, 1986), and a transmission approach to innovation (Krajcik, Blumenfeld, Marz, & Soloway, 1994; Robertson, 1994), have been critiqued. Wagner (1997) argues that these approaches to research may widen the equity gap by ignoring the particular contexts of schools and students, while reproducing

power inequalities between academic researchers and the teachers and student subjects.

This study was designed to narrow the equity gap by: (a) fostering culturally relevant and appropriate science education, (b) increasing and improving the quality of participation in science education for marginalized middle school science students, (c) engaging these students in investigation and resolution of community environmental issues such as issues of environmental justice, (d) helping to bridge the school-home culture gap by engaging student knowledge about their communities through curricular activities and pedagogical approach, and (e) conducting collaborative research with a science teacher in an urban, school of marginalized (by race, SES, and the status of the school) science students. This study was not designed to raise students' scores on standardized tests, or to address additional equity issues such as gender.

How This Study Developed

In the 2003-2004 school year I worked with two middle school science teachers at Columbia Middle School to develop and evaluate curricular and pedagogical approaches to engaging students in science. One of the results of the study was that the participating teachers began to talk about – and shift – aspects of the science learning in the classroom. One teacher in particular engaged in the process of changing from a focus on independent curricular units (water unit, geology unit) taught through mostly a transmission, teacher-centered approach, to engaging in student-led inquiry through a more social constructivist model of

teaching and learning. One of the conclusions from analysis of student interviews was that many students had little respect for science curriculum that was divorced from life outside of school. Students talked with great excitement about the few activities we did that were hands-on and connected to community life.

This teacher, referred to in this study by the pseudonym Mark, wanted to pursue some of the issues that the pilot study raised: generating student participation in learning through eliciting their interests, investigating local environmental concerns, making connections to the community, and involving students in decisions about the curriculum.

Mark and I agreed to work collaboratively to plan, enact, evaluate, and replan a curriculum with the 8th-grade science students. We met through the end of the school year and then again in the late summer to talk about our general approach, the possible challenges, and our curriculum. We also discussed my dissertation questions, and my role as a collaborative researcher.

Dissertation Research Questions

This study addresses the following questions:

In a collaborative curricular and pedagogical innovation that elicits student knowledge about their communities through investigation of and action on community environmental issues,

1. How do students participate in the learning activities?
    a. Do students offer ideas in response to open-ended questions? Do students offer unsolicited comments, questions or ideas?

b. What forms of non-participation are expressed by students? Why?

c. Do students talk about what they are learning with their friends and family? Why or why Not?

2. How do students bridge from personal/cultural knowledge to scientific knowledge?

   a. In presentations and other curricular activities do students connect scientific knowledge with personal or cultural knowledge?

   b. What aspects of the curriculum and pedagogy help them to bridge these forms of knowledge?

3. Does the collaborative curriculum help to empower students as science learners and community members?

In reference to the collaborative innovation that forms the context for the proposed study, "curricular" and "pedagogical" refer to what the participating teacher calls, respectively, "content" and "delivery." Curriculum reflects the planned learning activities including class discussions, assignments, assessments, presentations, etc. Pedagogy includes the methods of instruction and the more subtle aspects of classroom culture such as the kinds of questions the teacher asks students and the relationship between teacher and students. The "collaborative curriculum" is also referred to as the "community environmental health program," or simply the "program," or the "project."

"Student knowledge" refers to knowledge gained primarily outside of school in the context of family, peers or other community members. Student

knowledge includes aspects of cultural knowledge common to members of a cultural group. Student participation is recorded as public academic talk (i.e., student raises hand to answer a question or offer an idea, student presentations, student-to-student talk on group work).

While I characterized the kinds of student knowledge that form the focus of the study as "personal/cultural knowledge," I did not delve into aspects of the personal or cultural. Because of the home/school divide for many minority students, and my interest in critical, multicultural science, my focus was on bridging from students' out-of-school knowledge to scientific/school knowledge. In other words, it was significant that we helped students' to bring personal/cultural knowledge to the science classroom. This is knowledge that came from participation in familial and social interactions outside of the classroom. Whether that knowledge was personal or cultural was not central to the study.

The out-of-school knowledge could be personal or cultural. By personal I mean knowledge based on the students' personal experience, such as smelling pollution or knowing an uncle who suffers with asthma. I use the term cultural knowledge to include ways of knowing based not only on personal experience but rather knowledge that may be particular to African American or Latino students. For example, many students expressed concern about discrimination against homeless people, and outrage at the injustices of environmental racism. These responses may be reflections of cultural knowledge of racism that are learned from participation in the African American and Latino communities.

Gender was not a focus of this study for two reasons: (a) I did not feel I could deeply examine my research questions using more than a few lenses, and (b) the action research and collaborative aspects of the study made for as much complexity as I could handle. In this dissertation, I mention issues of gender only the occasions where a clear pattern emerged from the data that I felt I could support with relevant literature.

I chose to focus on student participation for the following reasons: students' active engagement in classroom discussions, presentations and group work were central concerns for the collaborating teacher and emerged as significant issues in the pilot study, the emphasis on verbal interactions in African American culture, the ways in which participation offers a window into student learning, captures student language, and addresses the equity gap discussed in the first chapter of this dissertation.

In the formation of the research focus and questions, Mark's central concerns about his students and his teaching revolved around student participation. "Getting them riled up." meant to Mark raising the level and quality of student participation, excitement and emotional engagement of the students in science learning.

In the pilot study, students consistently talked bitterly of school being about "sit and listen." They were excited about speaking with other students or neighbors about what they were learning. This study's focus on encouraging and capturing

students' voices is a response to students' desire to be heard and counters their perception of school as a place where they are not heard.

In my pilot work and my reading of the research literature, I found that many students felt much more comfortable expressing themselves verbally than in writing. Delpit (1995) and Murrell (1994) describe the emphasis on verbal interactions as central to African American culture. Students' comments, questions and conversations about science learning offered a better view into what they were thinking. Listening to and recording students' comments in my notes gave me the opportunity to capture their voices, their language in a way that written assignments did not.

Commeyras (1995) argues that student participation is a window into student knowledge and learning. Looking at learning and knowing as an active social practice, expressed for instance in student participation, is central to a situated learning perspective on learning (Cobb & Bowers, 1999; Hogan, 2002). This perspective focuses on learning as a process of negotiation within a community and connects learning to issues of identity.

In our collaborative curriculum, we gave students many varied ways of participating in the learning: classroom brainstorming and discussion, small group work, presentations, joining the KBOO radio lunch group, writing for Street Roots newspaper. Students helped to define what we studied and how, and were given outlets for expressing their opinion and their grasp of scientific concepts. In this

way, student participation meant being engaged in negotiating and building knowledge.

Getting students to ask questions, offer ideas, and talk about science learning is a way to "get students to the table" (D. Miller-Jones, personal communication, May 9, 2006). Without getting these low-income, minority students to the table of science learning, I do not believe we can address the equity gap.

Looking at student-initiated and teacher-initiated comments would help me to get a sense of what kind of opportunities students had to participate in the class, and a student's level of empowerment in the class. Student-initiated comments are when students ask a question or make a statement without being prompted by the teacher. When a student interrupts the teacher talking to ask a relevant question such as "Can you get cancer from the environment?" I consider this to be a different kind of participation and empowerment than when students are answering the teacher's questions.

The focus on students' bridging of personal/cultural knowledge and scientific knowledge is informed by the assumption that students learn by building upon prior knowledge (Ernest, 1994), that the equity gap is caused in part by the sharp differences divide between students' school and home experiences (Barton, 2003), and that environmental justice issues faced by minority communities are opportunities for teaching science for empowerment (Running-Grass, 1996).

I use the terms "empowerment" and "agency" to mean both becoming aware of and using one's power to engage in social transformation. In other words, empowerment involves asserting oneself in the world to right injustices. Rodriguez and Berryman (2002) write, "Agency is … the conscious role that we choose to play in helping to bring about change for the benefit of all" (p. 1020).

Disempowerment (Barton & Yang, 2000), disengagement, silence (Kohl, 1994), and active resistance (Kohl, 1994) are all results of the equity gap, as well as issues that compound the equity gap. Many students, particularly minority and low SES students do not feel any identification with science learning and do not find ways to participate in the learning. Student empowerment is central to bridging the equity gap because it represents the students finding constructive responses to disengagement, to silenced voices, to feeling like they have not been given the respect they deserve. Empowerment is part of bringing students to the table, part of building a science education that reflects marginalized students' life experiences.

A Word on Science

As the conceptual framework describes, I approach science education as a way of connecting with marginalized students' prior personal and cultural knowledge (Atwater, 1996, Seiler, 2001), giving students choices in the learning (Tobin, Elmesky, & Seiler, 2003), and preparing students to participate in decision-making on issues involving science in their communities and in the larger world (Fourez, 1997; Roth & Desautels, 2002). Readers looking for the usual markers of

science – rock types, hypotheses or chemistry labs – will be surprised or perhaps disappointed.

The science learning in this study involves "reading the world for ourselves" (Smith & Williams, 1999, p. 62). Because science has historically been a practice of the empire, the teacher and I put a strong emphasis bringing the students' experience to the classroom to arrive at "mutual adaptation" of the two worlds (Barton & Yang, 2000, p. 887). Collaboratively reconstructing what science means from the perspective of those populations not historically at the table is a critical multicultural perspective on science.

Conclusion

This dissertation reflects an attempt to address injustices in science education and environmental education by understanding the meeting places of culture and science and empowering students marginalized by race and/or socioeconomic status. The equity gap describes a combination of inequities in environmental conditions, in access to and participation in education. This study is an effort to bridge the equity gap for marginalized middle school science students by conducting a collaborative study of a curricular innovation to understand how students connect personal/cultural knowledge and scientific knowledge.

The collaborative curriculum is designed to elicit students' personal and cultural knowledge, get students involved in the investigation of environmental issues in their neighborhoods, and include students in decisions about what to learn and how to learn it. The research questions revolve around bridging students'

personal/cultural knowledge and scientific knowledge, student learning, sense of agency, and participation. This dissertation tells the story of an effort to build a bridge between the small student nation, and the empire of school, a story of empowering science learners in the classroom and in their community. The conceptual framework that informs this study is based on a broad foundation of critical theory supporting the perspectives of multicultural education and social constructivist perspectives on teaching and learning.

CHAPTER II

CONCEPTUAL FRAMEWORK

The conceptual framework of the proposed study is based on critical theory. Critical theory offers a broad theoretical foundation in which specific curricular, pedagogical, and methodological proposals from multicultural education and social constructivist perspectives on teaching and learning are nested. I see social constructivism and multicultural education as nested within critical theory because the subjectivist epistemology of critical theory is central in both social constructivism and multicultural education. Figure 1 illustrates the relationship between the critical theory, multicultural education and social constructivist perspectives.

After defining critical theory, I critique environmental education and science education as currently practiced, describe the conception of science education for empowerment, and look at collaborative approaches to educational research. I offer a definition of multicultural education and review research on the home-school cultural divide, culturally relevant pedagogy, and teaching science as a cultural form of knowledge. Social constructivist perspectives on teaching and learning are considered including the valuing of student knowledge in science

education. Finally, specific examples of science education and environmental education in the community are considered (see Table 1).

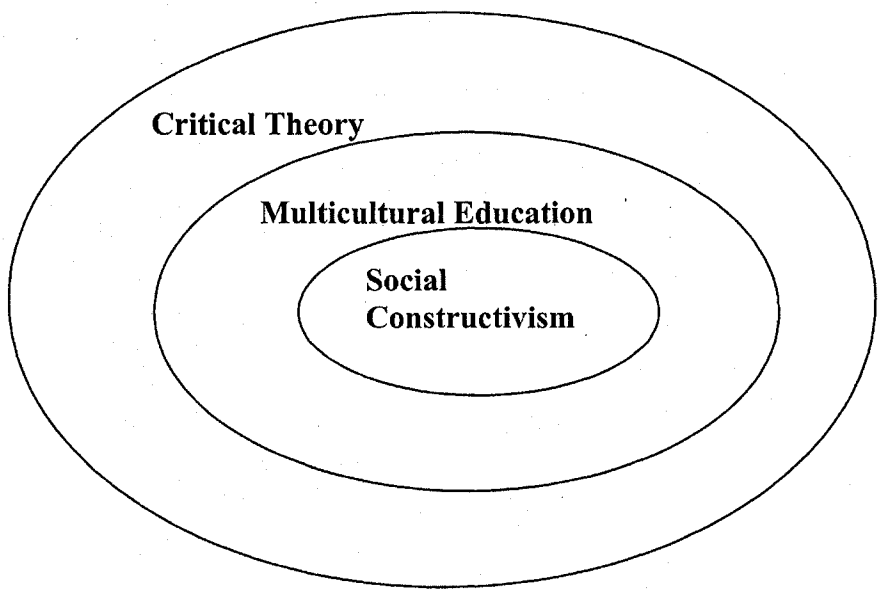

Figure 1. Conceptual framework.

Table 1

How Conceptual Framework Informs Literature Review and Research

	Critical Theory	**Multicultural Education**	**Social Constructivism**
Definition	Critique and empowerment for personal and social transformation	Provide all learners opportunities for empowerment and success	Active construction of knowledge by learners in social settings
Aspect of Proposed Research	Action research Collaboration with teacher Student agency in classroom	Bridging science and students' knowledge Giving voice to marginalized students	Curricular and pedagogical innovation that elicits student knowledge
Concepts from the Literature	Critique of science and environmental education Science education for empowerment Research collaboration Student voice	Home-School cultural divide Science as culture Science and ecological education in the community	Valuing student knowledge Science and ecological education in the community

Critical Theory

By critical theory I mean an approach to curriculum, pedagogy, and research grounded in critique for social transformation (Guba & Lincoln, 1998). Critical theory in education is focused on the ways in which schooling mirrors social problems in the larger society, such as power inequalities according to race, class, and gender, and the production of knowledge and culture (Barton, 1998). In the field of science education, critical theory offers a critique of the exclusionary ways that science education has been conceptualized and practiced, and proposals for how the field can be reconstructed by and for participation of marginalized groups such as African American, Latino, and poor students (Atwater, 1996).

Critique of Science Education and Environmental Education

The critical theory view of environmental education as historically and currently practiced is based on the implicit bias of European American middle class values (such as wilderness protection) (Taylor, 1996), the overwhelming reliance on the natural sciences (Lewis & James, 1995), a pedagogy focused on the transmission of predetermined knowledge (Smith & Williams, 1999), a reliance on behaviorist perspectives on learners and learning objectives (Robottom, 1987), and an almost exclusive use of quantitative research methodologies (Rickinson, 2001).

These historical characteristics of environmental education have denied diverse communities a voice by (a) ignoring the historical construction of environmental issues, including issues of race and class, (b) ignoring the particular contexts of the learners, and (c) relying on singular, monocultural definitions of

environmental problems and educational approaches (Lewis & James, 1995; Taylor, 1996). Scholars charge that behaviorist and objectivist characteristics of environmental education have proven unsuccessful in terms of pedagogy and research and run counter to the current educational emphasis on social constructivist perspectives on learning (Fien, 1993; Gigliotti, 1990; Robottom, 1987).

Within the field of science education a similar critique of inequalities and racial bias exists. Despite the science reform movement to craft a "science for all" (National Research Council, 1996), Barton (1998, 2003) and Seiler (2001) argue that these science reform efforts have ignored the needs and experiences of urban and minority students. Both Barton (1998, 2003) and Seiler argue that the culturally homogenous "one-size-fits-all" (Seiler, 2001, p. 1002) approach of "science for all" has overlooked the acculturating aspects of science education, and ignored the lived experiences of marginalized students.

In Barton's (2003) analysis, the science reform and standards efforts function on a "deficit model" (p. 26), focused on what certain marginalized populations lack and how they must change to catch up to the more successful science students. According to Barton (2003) and Seiler (2001), in order to achieve educational equity, it is the current content and pedagogy that need to change. The necessary changes are informed by multicultural education, social constructivist perspectives on teaching and learning, as well as by a new conception of the purpose of science education.

Science Education for Empowerment

The equity gap is, in part, about some communities having less access (to higher level science classes, to environmental protections) and, as a result, less power. Teaching science as a way to empower students as learners and community members is a direct response to the issues of the equity gap. Empowerment is about helping students to develop a sense of themselves as change agents in the personal and sociopolitical arenas. For example, empowerment at the personal level could mean starting to think about yourself as a successful science learner. Empowerment at the community or sociopolitical level might mean the process of understanding how knowledge of indoor air pollution can transform you into an activist with the capacity to improve the health of your family and neighbors.

Atwater (1996) writes about science education's role in empowering students, "Empowerment is the process by which students learn to use science knowledge that is outside their immediate experiences to broaden their understanding of science, themselves, and the world, and to realize the prospects for reforming the accepted assumptions about the way people should live in a scientifically diverse culture" (p. 831). Atwater's comments speak to the bridging that is the focus of this study; newly acquired scientific knowledge is applied to the students' personal and cultural knowledge to understand and act in the world in new ways.

Activities that are being developed for the curricular innovation such as projects on community environmental issues, the scientific autobiography, and the

scientific-student vernacular glossary allows students to make connections between newly learned scientific knowledge, their conceptions of science, and their worlds. Translating between "standard form" language and the students' vernacular language (such as the glossary) is an example of culturally relevant pedagogy (Ladson-Billings, 1995) and the teacher as a cultural broker (Aikenhead, 2002).

Freire (1995) writes about the human capacity to act as "subjects" (p. 3) to shape and reflect on our world, rather than merely adapting to it. Freire sees becoming subjects – liberation – as the purpose of all education. Rather than teaching science to prepare students for future scientific careers, or to transmit the knowledge of the discipline for its own sake, critical theorists such as Fourez (1997) and Roth and Desautels (2002) believe in teaching science to cultivate the students' sense of agency.

Fourez (1997) writes, "Are not our science courses often a means of pushing pupils into the world of scientists, rather than a way of helping them to explore their own world?" (p. 908). Fourez (1997) and Roth and Desautels (2002) argue that science education should prepare students to participate in decision-making on issues involving science in their communities and in the larger world. Roth and Desautels call this approach "science as/for sociopolitical action" (p. 7).

Collaborative Models of Educational Research

Several researchers expand the notion of empowerment by including teachers (Feldman, 1992; Goldstein, 2000) and students (Barton, 1998; Seiler, 2001; Tobin et al., 2003) in the development of curriculum and research.

Collaborative approaches to educational research are an answer to the gap between theory and practice, and the limitations of curricular innovations that do not include teachers in their development. There is a much-lamented gap between educational research and teacher practice (Blumenfeld, Krajcik, Marx & Soloway, 1994; Bouillion & Gomez, 2001). From my experience and my reading of the literature in science education and environmental education, many educational interventions, such as environmental education or science curricula, fail in their goals because of the complexities of teacher enactment of curricula (Bouillion & Gomez, 2001; Huberman & Middlebrooks, 2000; O'Donoghue, 1991). In other words, often teachers do not enact curricula as the curriculum developers intended. In their study of the enactment of a science inquiry curriculum, Huberman and Middlebrooks (2000) found that important aspects of the curriculum were "diluted" (p. 282) in classroom practice. They write that students' opportunities to ask questions and be active participants in the activities in the curriculum were limited because the teacher put more focus on the content objectives than the process of learning, and did not relinquish enough power to the students in the activities. Huberman and Middlebrooks conclude that the shift in math and science education to real-world, socially relevant topics, and social constructivist pedagogy demands that teachers make significant changes in their practices.

My pilot research confirms my reading of the literature on educational interventions. The teachers agreed to conduct a program based around inquiry, environmental and community stewardship, and the local watershed. The teachers

conducted several data collection activities common to environmental education (macroinvertebrate collection, water chemistry testing). In my analysis, these activities did not provide the students with opportunities to develop and pursue scientific inquiry or to learn important science concepts (such as water quality parameters for fish habitat and drinking water).

Critical theorists have suggested limitations of approaches to curriculum development and assessment that leave teachers and students out of the process (Robottom, 1987; Wals, 1994). Top-down approaches to curriculum development, research, and innovation may deny teachers and students a voice in the research process (Wagner, 1997; Robottom, 1987; Robottom & Hart, 1993).

Collaborative approaches to research are a solution to the gap between theory and practice, and the inequalities of traditional educational research. I believe it is crucial to carefully craft research that is *for* practice not merely o*n* practice (Bouillion & Gomez, 2001) by engaging the teachers in the planning and conducting of research, the observation of students, and the reflection on and evaluation of curriculum and pedagogy.

During the study, the participating teacher repeatedly remarked on the usefulness of the study for his teaching practice. Rather than conducting a study that focuses on description of pedagogy or student behavior in the classroom (*on* practice), the proposed study is designed to improve practice and student engagement in the classroom through collaborative innovation and the action research cycle of planning, enacting, and reflecting on the innovation. This means

the teacher learns with the researcher throughout the process, and the lessons are embedded in the teacher's classroom, the context of his work. Additionally the action research cycle allowed us to apply what we learned immediately, in the next cycle of planning, enactment, and reflection.

Kincheloe and McLaren (1998) write that research aligned with critical theory engages in "self-conscious criticism" (p. 265) to examine and emancipate oneself from oppressive ideologies. In the pilot study, both the participating teacher and I engaged in self-conscious criticism, particularly concerning our assessment of students' abilities and behaviors in the classroom, and how such assessments often hinder teaching practice and research (Fenyvesi, 2004). Wals (1994) argues that collaborative research produces "knowledge with emancipatory relevance" (p. 22). Emancipatory relevance means that participants in the research process gain new awareness of aspects of their practice and how they can change them.

Recent studies propose collaborative models of curriculum design, educational innovation, and research in which teachers join together with university researchers to study innovations, teacher learning, and student learning (Blumenfeld, Krajcik et al., 1994; Bouillion & Gomez, 2001; Krajcik et al., 1994; Stapp, Wals, & Stankorb, 1996). This literature suggests that successful innovations (a) consider the teachers' beliefs and the context of the school (Blumenfeld, Krajcik et al., 1994), (b) support teachers in their learning about enacting the innovation through collaboration and reflection (Stapp et al., 1996;

Wals, 1994), and (c) remake existing curricula to be relevant to local needs and contexts (O'Donoghue, 1991).

In this study I paid attention to developing trust with the teacher by always considering his needs in the context of the research, by listening to his concerns about the school and the students, and by playing multiple support roles in the classroom: researcher, assistant, field trip organizer, chaperone, and guest teacher. This trust allowed for an atmosphere of support in which beliefs and practices were challenged.

Collaboration with Students

Barton (1998, 2001, 2003) and Seiler (2001) extend their critical theory approach to science education to their research design. Barton (2001) recommends participatory research that amplifies youths' voices in the research community by shifting from "research *on* [italics added] to research *with* [italics added]" (p. 912). Seiler (2001) writes, "I have come to envision student involvement in research and curriculum development as a way to reverse the power structure of school, which has been oppressive to African American students" (p. 1001).

Both because my research questions involve the students' knowledge, and because my overarching goal is the empowerment of marginalized students in the context of science education, it is important that I found meaningful ways of including students in the study. Throughout the study, I used student interviews as opportunities to include students in the research process. I checked my interpretations of data with students, asked them to troubleshoot on questions of

student participation, and discussed with them possibilities for connecting their interests with the science curriculum. My use of the students' language in this dissertation is another way of elevating the students to the level of collaborators in the study.

Amplifying Students' Voices in the Classroom

Critical theorists note that one of the fundamental inequalities in education is the fact that students are rarely consulted in their own learning process (Cook-Sather, 2002). Cook-Sather writes that power must be redistributed within the classroom and the teacher must look at learning as a collaborative process. Blumenfeld, Soloway et al. (1994) and Moss, Abrams, and Kull (1998) describe similar science innovations that failed to foster conceptual change and learning of science concepts partially because the participating students were not given ownership over the projects around which the curriculum was based. Moss et al. describe an innovation that involved students mainly in data collection, not in the formulation of scientific questions that guided the class projects.

Tobin et al. (2003) recommend "student-driven" curriculum to engage marginalized science students. Much of the resistance that researchers have described between African American students and poor European American students is attributed to issues of power and control in the classroom (Irvine & Irvine, 1995; MacLeod, 1991; Ogbu, 1978; Tobin, Seiler & Walls, 1999). For example, Boykin and Ellison (1995) describe the negative effects of authoritarian aspects of classroom culture (punishment, sanctions) on African American

students. Tobin, Roth, and Zimmerman (2001) write that marginalized students often experience powerlessness in school.

This study fosters the amplification of students' voices through a curriculum that elicits students' knowledge, and invites students to make choices in what and how they will learn. When students are encouraged to have a voice in the classroom, teachers and researchers have the opportunity to learn about the culture of the students, and to start to negotiate cultural differences.

Multicultural Education

The goal of multicultural education is to provide all learners opportunities for empowerment and success (Rodriguez, 1998). Multicultural science education is informed by critical theory in its critique of structural (what populations of students are denied access to advanced science courses) and ideological (the cultural bias within science education) oppression and focus on empowerment.

Multicultural education informs an approach to curriculum and pedagogy that helps students to understand the socially constructed nature of knowledge (Banks et al., 2001). It shares with social constructivism an emphasis on the social and cultural context of disciplinary knowledge (such as science), as well as the importance of bringing students' experiences into the classroom (Atwater, 1996; Rodriguez, 1998). Multicultural science education is focused on critiquing the deficit model embedded in the notion of the achievement gap (Delpit, 1995; Seiler, 2001) and raising the participation of populations who have been left out of science (Atwater, 1996; Hodson, 1999). The understanding that school science and the

students' home lives are embedded in different cultures is central to my view of the equity gap and its solutions.

The Cultural Disconnect Between Home and School

Levinson, Foley, and Holland (1996) write, "Schools are sites where the dominant culture is reproduced" (p. 2). Students of cultural backgrounds other than European American middle class often experience a cultural discontinuity and may respond with alienation and hostility (Irvine & Irvine, 1995).

There is ample research that suggests that one of the reasons for the achievement gap is the cultural divide between home culture and school culture for marginalized students (Barton & Yang, 2000; Seiler, 2001; Smith-Maddox, 1998). Erickson (as cited in Smith-Maddox, 1998) writes, "Student failure is situated at the cultural mismatch between students and school" (p. 303). In an e-mail exchange about the many causes of the achievement gap, K. Singh (personal communication, May 5, 2003), a research scientist and National Science Foundation staff, writes, "Students/parents/families in poor/minority communities are more likely to experience the community-school disconnect."

In their article "Learning to Teach Science in Urban Schools," Tobin et al. (2001) suggest that "teachers have to learn to identify and connect with the social and cultural resources of their students" (p. 943). In this study, the researcher as teacher (Tobin) failed to acknowledge aspects of student culture such as issues of respect and authority. Because of this he was unsuccessful in creating experiences for the students to learn science.

Barton and Yang (2000) offer a rich, detailed account of the experiences of a homeless urban minority teenager's experience with science. Miguel, the young man who is the subject of their research, raised and studied reptiles and amphibians at home for many years and became "in his own words, a self-taught herpetologist" (p. 872). However, his interests and experience in biology were never bridged to school science and he dropped out of school. The authors argue that family and community pressures and the restrictiveness of the school culture prevented Miguel from being successful in school science. Barton and Yang conclude, "Miguel's story seems to be arguing for starting points toward science literacy grounded in the interests and cultures of all children while also recognizing the need for mutual accommodation between science education and children and youth from the inner city" (p. 887).

Miguel's story echoes some of the experiences I have had with marginalized students. On a field trip during my pilot study, a student who had difficulty maintaining interest in science class called me over to show me a tadpole and talk to me at length about the turtles and frogs he used to raise. I am confident that his teachers were unaware of his interests. I know that he had not had the opportunity, aside from occasional field trips, to pursue his interests in science class.

This study is informed by the belief that curriculum and pedagogy must (a) elicit students' interests, their home life and non-school (personal, cultural) knowledge; (b) provide activities that allow for students to connect their knowledge

to scientific knowledge; and (c) help students to feel empowered with some level of control over their science learning in order to make connections between home and school.

Accommodations between school science and the cultures of urban, minority students are difficult to make within the framework of science education as the transmission of objective, value-free truths. Approaches to science and environmental education informed by critical theory and multicultural education view science not as a set of objective information to be transmitted to the learner but as one among many cultural perspectives (Gough, 1999; Hodson, 1999; Stanley & Brickhouse, 2001). Creating learning experiences that allow students to construct knowledge and valuing students' knowledge are central to bridging the home to school cultural divide for marginalized students.

Social Constructivist Perspectives on Teaching and Learning

I refer to social constructivism as an approach to teaching and learning which emphasizes the active role of the individual learner in a social setting constructing knowledge and understanding that is based on previously built understandings (Ernest, 1994; Perkins, 1999). Additionally I draw on the theory of situated learning that posits that knowing and learning are inextricably embedded within a social context (Cobb & Bowers, 1999). Here I briefly discuss these theoretical perspectives and how they inform both the curricular innovations and research methodology of the study.

In my pilot study I found that although the students engaged in hands-on activities, such as using water chemistry test kits (mixing chemicals is an active process), these activities were often not clearly connected to learning goals. In other words, many students learned how to manipulate the beakers and chemicals but could not express the reason for testing the water.

From my perspective, the active building of knowledge means the students develop understandings of the activities they engage in. In the collaborative curricular innovations of this study, students engaged in hands-on activities in conjunction with building understandings of the concepts surrounding those activities. For example, students worked in small groups to describe community environmental issues and develop a plan for investigating and acting on those issues. Students learned some basic procedures for identifying lichen but those procedures were linked to the issue they had chosen, air quality.

In the social constructivist perspective, the role of the teacher is one of facilitator and co-participant (Marshall, 1992) who organizes experiences, such as authentic problem-solving, for the students' active construction of knowledge (Perkins, 1999). Teachers must find a balance between allowing learners to build their own knowledge and guiding the learners toward socially accepted knowledge (i.e., scientific knowledge). However, from a social constructivist perspective, guiding students toward socially accepted knowledge does not mean leading them toward predetermined "correct" answers or ideas. The balance between students building their own understandings and guiding them toward socially accepted

knowledge (such as scientific concepts) is something the cooperating teacher and I discussed often during the study.

Ernest (1994) places the focus of social constructivism on the individual learner in the social setting. The "shared world" (Ernest, 1994, p. 9), the language, and the prior knowledge of the students are central to a social constructivist perspective. Atwater (1996) offers that urban minority students' use of scientific knowledge in everyday life is a prime example of a social constructivist approach to science education. In other words, in order to make sense of scientific concepts in school, students need to use their prior knowledge. Particularly for marginalized eighth graders with little background in school science, much of the prior knowledge is cultural and personal knowledge.

The situated learning perspective posits that all knowledge is embedded in a social context. Knowing is a continual process of learners negotiating meaning (Lave & Wenger, 1991). The situated learning perspective raises issues of identity-building through participation in a community, as well as boundary-crossing between different contexts, different communities of learners (Wenger, 1998).

The personal and cultural knowledge of marginalized students is not usually accessed or invoked in the school setting (Barton, 1998; Delpit, 1995; Seiler, 2001). For example, a student's knowledge about where it is safe to catch fish to eat is embedded in a family or community context, and not in the science class. The fact that school science seldom draws from the student's out-of-school contexts

reduces opportunities for marginalized students to participate in science education (Barton, 1998; Seiler 2001).

This study focused on facilitating and capturing the students' ability to bridge the contexts of home/community and science class in a way that cultivates student participation and learning. This involves calling upon the students' prior out-of-school knowledge and broadening the context of science class to bridge school and out-of-school knowledge.

The social context of this population of learners (socioeconomic status, race/cultural group, neighborhood) plays a central role in the curriculum through the investigation of neighborhood issues and through activities that invite the students' personal and cultural knowledge about their communities. In addition, many curricular activities involved small groups of students, and provided opportunities for the students to build knowledge from their experiences.

For example, the science autobiography specifically drew on the students' perspective on their past experience with science. In the framing of the questions for this assignment we encouraged students to think of science learning as happening both in and out of school, in a variety of contexts.

In the social constructivist and situated learning perspectives I have discussed, the focus is not on the individual learner, but rather on the learner in the social context as a participant in the social practice of the classroom (Cobb & Bowers, 1996; Ernest, 1994). As a researcher I was not interested (only) in these

eight students' particular constructions of scientific concepts but rather on their learning and participating in the larger science class

In this study I focused my interviews and observations on eight students but always grounded the data in the broader context of the classroom. These eight students participated with other students within the context of the curriculum and pedagogy that the participating teacher and I enacted. Additionally, I chose to use focus groups for my interviews in part because of the importance of the way students construct meaning through social interaction. In specifically seeking the students' perspectives I hoped to understand how they learn and participate in science class and how they connect science learning with their personal and cultural contexts.

Valuing Students' Knowledge

Making the learners' particular constructions of knowledge explicit in the classroom is an important aspect of pedagogy based on a social constructivist perspective. The curricular and pedagogical innovation that the teacher and I developed is an approach that elicits the students' knowledge about their communities through investigation of and action on community environmental issues. Particularly in my pilot study, I found that the teachers tended to use a transmission model of pedagogy. This approach denied students a chance to express their knowledge and, as a result, reduced the potential for student engagement and learning. The studies cited below posit science learning based on the students' experience and knowledge.

The title of Seiler's (2001) article makes this social constructivist and multicultural approach to science education explicit, "Reversing the 'standard' direction: Science emerging from the lives of African American students." Seiler argues that science content should come not from the "one-size-fits-all" approach of national standards, but rather from the lives of non-majority culture students. Similarly, Barton and Yang's (2000) vision of science literacy centers on the students' experience. They write, "Science literacy must be grounded in the interests and cultures of all children while also recognizing the need for mutual accommodation between science education and children and youth from the inner city" (p. 887). In other words, all three of these studies strive to "learn from the students how science education can change to meet their aims" (Seiler, 2001, p. 1000). This focus on the student as the focal point for curriculum and pedagogy has implications for issues of student control in the classroom.

Seiler (2001) and Barton (1998) provide examples of science education programs that put students' lived experiences at the center of the learning. Seiler conducted a science lunch group in an inner city high school that provided the students the possibility to learn science originating from their own questions and to "recognize science in their everyday activities" (p. 1012). They learned about the physics of sound through drumming, and chemistry through hair products. In very similar research, Barton taught science in a homeless shelter by exploring students' questions about food, nutrition, and pollution in their neighborhood. While I appreciate the radically student centered approach outlined in Barton and Seiler,

because the studies took place outside of the K-12 science classroom, their recommendations are not fully applicable to the classroom setting.

In my pilot and dissertation study, I spoke with many 8th-grade science students about their interests and how those interests could be incorporated into science class. Students expressed excitement about getting involved in community issues: gardening on school grounds, cleaning up the air, neighborhood storm drain marking, cleaning up parks.

Delpit (1995) argues that progressive educators often make the mistake of building content solely on a student's cultural knowledge and daily experience. This approach does not give the marginalized students access to success in the larger society. Delpit indicates that, while educators should draw on the culture of the students to facilitate learning, marginalized students must be given the mainstream content that other cultures get at home. Part of my research focus was creating and examining curricular opportunities for students to connect personal and cultural knowledge to mainstream knowledge, in this case, scientific knowledge. Doing science in the context of the communities surrounding the school is one way to elicit students' interests and cultural knowledge, and to practice science for empowerment.

Science Education and Environmental Education in the Community

The collaborative curricular innovation in this study was focused on engaging students in investigation of and action on community issues. The use of issues in the community where many of the students live provides an opportunity

for (a) valuing student knowledge and experience, including cultural knowledge, (b) connecting student knowledge and scientific knowledge, (c) engaging environmental problems relevant to that community such as environmental justice issues, (d) framing an experience for the students to actively construct knowledge, and (e) providing real-world tasks such as research plans and presentations that align with authentic and culturally-relevant pedagogy and assessment (Fusco & Barton, 2001; Smith-Maddox, 1998).

Ecological education often takes the form of investigation of local issues relevant to the students through partnerships with the community (Ballantyne, Fien, & Packer, 2001; Lieberman & Hoody, 1999; Smith, 2002; Stapp et al., 1996). Smith (2002) and Smith and Williams (1999) offer examples of place-based education such as students creating gardens on school grounds, doing oral history projects, investigating and restoring nearby wetlands or conducting community assessments. Stapp et al. (1996) describe the development of several K-12 school curricula they term "Action Research and Community Problem Solving." In these projects teachers, university researchers, and students collaborate to investigate, act and reflect upon community problems of the students' choice.

Bouillion and Gomez (2001) studied a community science program with minority students in a Chicago elementary school. The students chose to investigate and clean a neglected and polluted portion of the banks of the Chicago River near their school. The school partnered with local organizations to collect and analyze data, devise a plan for restoration, and engage the community in the restoration of

the riverbank. Bouillion and Gomez argue that the program had positive outcomes: students learned important science concepts and skills in collecting and analyzing data, and their positive attitude toward science and sense of efficacy in doing science was enhanced. In conclusion, Bouillion and Gomez posit the potential of school-community partnerships for solving real-world programs to bridge the school-community gap facing diverse urban schools. However, the limitations of the study were that Bouillion and Gomez did not offer a detailed description of the students' or teachers' experience (they studied 10 schools), and they did not use multiple assessments, or sources of data, on which to base their conclusion about the learning of science concepts.

Lieberman and Hoody (1999) conducted a study of 40 schools in which the schools' surroundings and community provided a framework for student learning, an approach they call "Environment as an integrating context for learning (EIC)" (p. 4). Students in an Iowa school landscaped their school campus while studying ecology and mathematics, and students in Los Angeles conducted a major study on the restoration of local wetlands. On the basis of interviews with teachers, site visits and analysis of GPAs and test scores, Lieberman and Hoody write that the benefits of EIC programs include "better performance on standardized measures of academic achievement... and increased engagement and enthusiasm for learning" (p. 4). Many of Lieberman and Hoody's conclusions about student engagement and learning rest solely on surveys completed by participating teacher or standardized tests.

Many informal, extracurricular youth programs have been successful anecdotally at engaging urban minority students in learning and action around issues such as: air quality monitoring and asthma (Henry, 1996), lead poisoning (Taylor, 1996), community environmental art (Di Chiro, 2002), and oral history and racism (King, 1995), but none of these examples has been studied in-depth by educational researchers.

Summary of Literature Review

A wide range of literature informs my work on science education with marginalized middle school science students. The equity gap and shortcomings of science education and environmental education were considered as the background to my work. Among the proposals for science education for equity were: conception of science education for empowerment, exploring the meeting places of science and culture, incorporating students' interests and culture in science education, engaging students in science learning and action in the community, and approaches to educational research that involve collaborating with teachers and students.

Many researchers have called for in-depth studies into ecological and science education with urban minority students (Barton, 1998, 2001; Barton & Yang, 2000; Lewis & James, 1995; Mayeno, 2000; Seiler, 2001). Bouillion and Gomez (2001) call for additional research into understanding community-based science as a bridge between school and community knowledge in the science education of urban students. On the basis of their research in science education in urban schools, Tobin

et al. (1999) write, "It is essential that research identify ways to tailor the science curriculum to the needs and interests of the students" (p. 171).

Much of the research on science and ecological education with marginalized students describes settings outside of the K-12 science classroom (Barton, 1998; Seiler, 2001), brief anecdotal accounts (Smith, 2002; Taylor, 1996), or large-scale studies that dealt with 10 or more schools (Bouillion & Gomez, 2001; Lieberman & Hoody, 1999). No studies addressed in detail the students' experience in a student-centered curriculum, student participation, or connecting student knowledge and scientific knowledge in a K-12 science classroom. The proposed research helps to fill this gap.

CHAPTER III

CURRICULUM

General Approach and Rationale

In this chapter a general picture is painted of the curriculum and how it was created. The process of collaborative curriculum development, implementation and modification is explained here as a reflection of the conceptual framework described in chapter 2, and the context for data collection and analysis discussed in chapters 4, 5, and 6.

I strived to address the equity gap by empowering the teacher and students in curriculum development, by making the learning relevant to student and local community needs, and by enlarging the boundaries of science to include new voices and sociopolitical issues. "Curriculum" may not be the appropriate word for the learning that Mark, the students, and I planned because it differed strongly from other curricula I examined. It was flexible and loosely structured, unlike an off-the-shelf science or environmental education curriculum. Because of our approach – elevating student knowledge, giving students choices in learning activities, and embedding the program in an action research process of planning, doing, evaluating, and (re)-planning – the curriculum was constructed as we went. We planned weekly, based on what the students had come up with the previous week and our general outline.

Perhaps the most distinguishing aspect of our curriculum was that there was almost no predetermined content. Unlike so many curricula, we did not begin by stating our objectives (e.g., students will understand five different toxins in the air, and learn how to conduct a neighborhood health survey). What Mark and I planned was the general context: community environmental justice issues, connections between student knowledge and scientific knowledge. We also planned to include certain types of activities such as public presentations.

As Mark reminded me during one of our planning meetings, "When you plan too much, you lose the process." What he meant was if we provide a detailed plan, it leaves little room for the process of generating interest and ideas from the students. A loose structuring of the program allowed us to be responsive to student interests and gave them a say in the curriculum.

Curriculum Planning Process

In spring and early fall meetings with the teacher we discussed lessons from the pilot study and outlined initial steps we would take with the students. All activities (assignments, discussions, presentations) were jointly planned by the teacher and me. The collaborative planning often involved a half-hour conversation during the teacher's planning or lunch period or on the phone in the evening. Based on our conversation I would usually write up a plan or activity, make changes with Mark, and then make copies of the article or whatever texts were needed. Mark would facilitate the class session based on our discussion.

At particular junctions in the program, such as after students voted on issues to pursue, I wrote up a few different ideas (based on analysis of the data, "Urban Stewards" curriculum, etc.) on what the next steps could be and emailed them to Mark. Then Mark and I discussed my notes and came up with a plan.

Curriculum Evaluation and Modification

Evaluation was conducted through data analysis and conversations with the teacher. After each day we would discuss and revise the activities, sometimes making changes hurriedly between classes. This continual revision based on a cycle of planning, implementation, analysis, planning, and revised implementation is inherent in the action research process.

For example, we started the curriculum by asking students to list community environmental issues. After reading their ideas (blank papers, very short lists reflecting mostly examples we had discussed in class), we realized we needed to help students build understandings of community through class discussions, mapping, and then surveying neighbors. A few weeks later, the students developed much richer lists of community environmental issues and votes on which to pursue.

Other changes we made had to do with encouraging student participation. A very strong early theme in my data was that many students did not talk in class for fear of being ridiculed by other students. After discussing this, Mark and I brought the issue to the students and tried to set new norms of respect in the classroom.

Curriculum Resources

Although some of the literature described in chapter 2 offers brief descriptions of learning activities aligned with our approach, none of the articles explained activities in the level of detail that would have been useful to us. Half a dozen curricula on urban environmental education and community-based environmental education were read in preparation for this study, but few of them put the students in decision making roles in the lessons, and all lacked discussions of race, class, and power in environmental issues. The only curriculum that both Mark and I read and borrowed ideas from was "Urban Stewards."

Urban Stewards is a program of Eco-Education, a not-for-profit organization that trains teachers and runs programs in low-income urban schools in Minneapolis, Minnesota. "Urban Stewards" focuses on the students as leaders in learning activities and characterizes the teacher's role as facilitator. Additionally, this curriculum emphasizes student-led investigations of their own neighborhoods. It is important to note that it was Mark who decided that "Urban Stewards" was worth borrowing from for our work.

When Mark and I presented at the North American Association for Environmental Education conference, we saw a presentation by a staff member of Eco-Education and spent time talking about our work with her at lunch. These conversations helped to push both of us along the student-led, local issue investigation path and encouraged us to allow or encourage students to redefine what counted as an environmental issue.

At the presentation, the Eco-Education staff member mentioned that garbage and graffiti were common issues chosen by the urban students of color with whom she worked. Mark looked at me and smiled; our students had identified and chosen the same issues. After the presentation, Mark told me and the Eco-Education staff member that he felt "affirmed" hearing about the similarities in our programs.

Mark rarely experienced affirmation or support for his teaching at Columbia Middle School. He was taking risks in committing to our collaborative study. It took time away from the district-mandated curriculum; he was asked to justify some of the activities we did to the school administration; and it meant leaving behind familiar ways of doing things in the classroom. For these reasons, the affirmation Mark and I received from presenting and listening to other presenters at the conference was significant.

Activities in the Curriculum

All 8th-grade science classes I worked with at CMS designed a neighborhood survey, made observations, and generated a list of issues to study. Three classes chose to study air pollution and asthma. One class chose to study homelessness. Mark and I supported the students' choice of homelessness; it qualified as a neighborhood issue according to the students' observations and surveys. Additionally, allowing the students to make decisions about what to study and how was more important than enforcing the traditional boundaries of science.

Brief descriptions are offered of some of the activities that we planned and conducted during the study. Copies of student work on some of these activities can be found in Appendix E.

- Science Autobiography: Students were given a blank sheet of unlined paper with the heading "Science in My Life: Write a story and draw a picture." This assignment was completed in September and again in February.
- "What is Community?" Discussion: Students worked in table groups (3-4) and then as a whole class to develop a list of what community was to them. The teacher compiled the lists on large sheets of paper that we hung on the classroom walls.
- Neighborhood Survey: "Getting to Know your Neighborhood." We spent several class sessions creating this 2-page survey with the students. It consisted of student suggestions on how to gather information about where they live: street tree and traffic count, observations, and survey questions to ask neighbors.
- Guest Speakers: Students suggested homeless people and scientists as guest speakers. I arranged for a formerly homeless woman, the editor of Street Roots (Portland weekly paper covering homeless issues), and an environmental studies professor from Lewis and Clark College to visit CMS (Columbia Middle School) and speak with the students.

The students were asked to write questions beforehand and offer their thoughts on the guest speakers after the speakers left.

- Two-on-two Presentations to Younger Students: Pairs of eighth graders taught pairs of second, sixth or seventh graders about air pollution, mapping, lichens, and asthma. The students as a class decided what they would teach, with help from the teacher and I.
- Ten students from the class that chose to study homelessness wrote articles, poems or drew pictures for Street Roots newspaper. I often helped students work on their writing during lunch.
- Eight students participated in a lunchtime KBOO radio group, recording interviews of students and teachers, writing text, and doing raps on air pollution, asthma and related community issues for a radio program that was aired on KBOO 90.5 community radio at the end of March.

The above events were important learning activities as well as sources of data for the study. I observed the activities and discussed students' reactions to the activities in interviews. As a researcher these activities offered insight into the students' experience in the program, their learning, and particularly the ways in which they connected, or did not connect, science learning to their lives outside of school.

CHAPTER IV

RESEARCH DESIGN AND METHODOLOGY

The purpose of this study is to understand whether and how marginalized 8th-grade science students bridge personal/cultural knowledge and scientific knowledge in ways that enhance student participation and science learning. This intent and the research questions listed below fit well with a qualitative action research design.

The following aspects of research design and methodology are discussed in this chapter: research questions, rationale, setting and participants, data collection and analysis, time frame, researcher roles, ethical issues, and limitations.

Research Questions

The study was initiated based on the following research questions:
In a collaborative curricular and pedagogical innovation that elicits student knowledge through investigation of and action on community environmental issues,

1. What is the quantity and quality of student participation?
    a. Which students engage in public academic talk? When? What do they say?
    b. Do students offer ideas in response to open-ended questions? Do students offer unsolicited comments, questions or ideas?

c. What forms of non-participation are expressed? Why?

2. How do students bridge from personal/cultural knowledge to scientific knowledge?
   a. In presentations and other curricular activities do students connect scientific knowledge with personal or cultural knowledge?
   b. What aspects of the curriculum and pedagogy help them to bridge these forms of knowledge?
3. How does this approach inform student learning of 8th-grade science benchmarks?

These questions were chosen because, based on my experience and the literature, making connections between personal/cultural knowledge and scientific learning has the potential to bridge the equity gap for marginalized science students. Student participation was chosen as a focus because it offers a window into student knowledge and learning (Commeyras, 1995), verbal interactions are often given emphasis in African American culture (Delpit, 1995; Murrell, 1994), and because students in the pilot study frequently critiqued their passive role in the classroom. Encouraging and observing student participation is one way of bringing students' voices into the classroom.

Shifts in the Research Questions

The focus of the study remained close to the original research questions. Over the course of the data collection and analysis I changed the following: I rephrased question number one to reflect a more general focus on participation and

I removed the research question on science learning and benchmarks. I added a question on aspects of the curriculum that facilitated bridging, a subquestion on students talking about science learning with friends and family, and a question on student empowerment.

For this dissertation, my research questions emerged as the following: In a collaborative curricular and pedagogical innovation that elicits student knowledge about their communities through investigation of and action on community environmental issues,

1. How do students participate in the learning activities?
    a. Do students offer ideas in response to open-ended questions? Do students offer unsolicited comments, questions or ideas?
    b. What forms of non-participation are expressed by students? Why?
    c. Do students talk about what they are learning with their friends and family? Why or Why Not?
2. In presentations and other curricular activities do students connect scientific knowledge with personal or cultural knowledge? What aspects of the curriculum and pedagogy help them to bridge these forms of knowledge?
3. Does the collaborative curriculum help to empower students as science learners and community members?

Creswell (2003) writes about research questions, "Often in qualitative studies, the questions are under continual review and reformulation" (p. 107). Rather than remaining rigidly bound to my pre-research assumptions, I followed

the most compelling leads within the data. In this process, findings on student views on school, knowledge and language, and the student process of empowerment took on more significance in the study than some data on student learning.

My research question on science learning and 8th-grade benchmarks proved to be more complex and less directly related to the research focus than the other questions. Because of the nature of the benchmarks themselves, and the fact that benchmarks were not used to assess student work, it made sense to drop that research question and to pursue the remaining questions for which I could collect relevant data.

I added the questions on curriculum and bridging because this emerged as a central theme in the data. Evaluating aspects of the curriculum provided critical information for Mark and me during the study. In the community environmental health curriculum I found that students were talking with family and peers about what they were learning in science class. Because of the separation of home and school for students, I realized that this data was significant and deserved a subquestion under participation.

Over the course of the study I observed students' perceptions of their roles in science class and their community change. I saw students asserting themselves in the classroom and in presentations to other students. For this reason, empowerment became central to the study demanded a new research question.

Research Methodology and Design

A qualitative methodology guided my research because it: (a) captures context (Marshall & Rossman, 1989), (b) examines the interaction of variables in a complex setting (Miles & Huberman, 1994), (c) fosters empowerment, particularly for marginalized groups (Guba & Lincoln, 1998), and (d) explicitly emphasizes and considers the close relationship between the researcher and the context and participants (Ely, Anzul, Friedman, Garner, & McCormack Steinmetz, 1991). These characteristics of a qualitative approach suggest it is likely to produce meaningful data for the proposed study.

An action research design is the most appropriate for the research we conducted because: (a) the cyclical process of action research offers an appropriate structure for research that informs curriculum and pedagogy (Stapp et al., 1996); (b) the empowerment of participating teachers and the continual interplay between action and reflection in action research "encourages teachers to develop a more refined understanding of their own problems and practices" (Carr & Kemmis, 1986, p. 126); (c) action research places value on collaboration and the empowerment of the participants (Greenwood & Levin, 1998); and (d) my work takes place within the broader context of the equity gap and action research is conceptualized as research for social change (Greenwood & Levin, 1998; Kemmis & McTaggart, 1998).

The trust and collaboration developed during the pilot study with the participating teacher offered great potential for an action research study. Feldman

and Minstrell (2000) write that in their action research with physics teachers, two years were needed to complete the study. Much of the first year was used to redefine research priorities and build collaboration with the teachers. Figure 2 illustrates the cycle of planning, action, and reflection that is central to an action research design (Carr & Kemmis, 1986; Stapp et al., 1996).

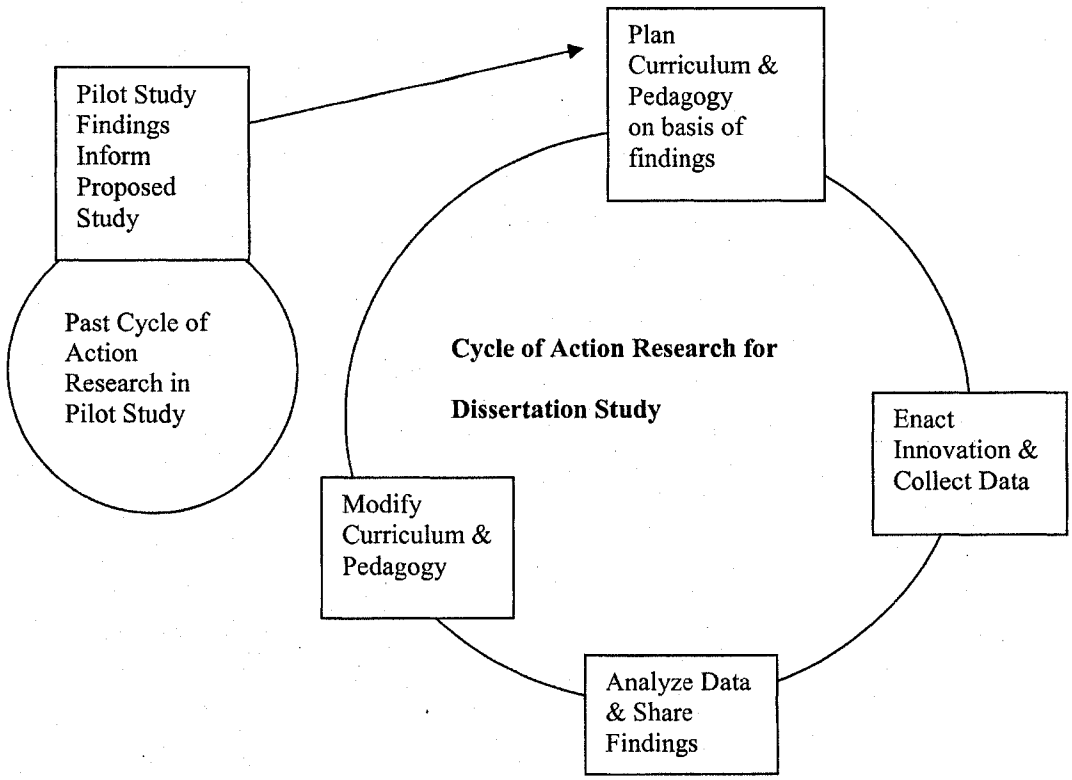

Figure 2. The cycle of action research. Mordock and Krasny (2001).

Setting and Participants

The setting for my research is a public middle school located in Portland. To protect the participants the school is called Columbia Middle School (CMS). The participants include one science teacher with two 8th-grade classes with

approximately 55 students total. The school is located in an industrial area adjacent to low income residential neighborhoods. A clear illustration of environmental justice issues, the area around the school has high concentrations of diesel air pollution, illegal dumpsites, and industries generating hazardous waste (Multnomah County Health Department, 2003). According to school district data, 60% of the students qualify for free or reduced lunch (an indicator of low socioeconomic status), and 65% are minority students, with African American students making up most of the minority population.

The school is categorized as not meeting federal adequate yearly progress (Oregon Department of Education, n.d.). This means that in 2001-2002 and 2002-2003 less than 40% of the students in English/Language Arts and less than 39% of the students in Mathematics met or exceeded state standards. In addition, CMS students' attendance rating did not meet the statewide goal of a minimum of 92%. Teachers at the school and school district staff often refer to CMS as a "failing school."

The participating 8th-grade science teacher self-identifies as African American and lives in the same neighborhood as many of the students. At the time of our study, Mark (a pseudonym) had been teaching science for five years, two of those years at CMS. Mark often spoke of his commitment to working with this population (low income African American and Latino students), but he was deeply dissatisfied with the administration and some of the teachers at CMS.

This teacher was chosen initially for the pilot study through interviews with middle school science teachers who work in schools with the subject population (minority, low socioeconomic status, low standardized test scores). Of the two teachers who participated in the pilot study, the cooperating teacher for the dissertation study was the only 8th-grade science teacher for the 2004-2005 school year.

The participating teacher identifies as African American, and this could be an important factor in the proposed study. The particular pedagogical and cultural dynamics and the successes of the teachers who share membership in the racial or cultural group of the majority of their students have been noted by researchers (Ladson-Billings, 1995). Although these particular dynamics are not the focus of this study, I am aware that the shared racial/cultural membership of the teacher and the majority of students may affect pedagogy, classroom discourse, and other issues. Students may be better able to relate to Mark than to white teachers; they may feel more comfortable in sharing personal and cultural knowledge, and mutual respect might be easier to achieve.

The populations of students who are the participants cross several racial and socioeconomic categories. The students at the middle school are referred to generally as "urban minority" or "marginalized" because of the following:

- their race and/or socioeconomic status excludes them from the "culture of power" in schools (Delpit, 1995, p. 24).

- their race and/or socioeconomic status excludes them from participation in the culture of science and science education (Barton, 1998; Seiler, 2001).
- the status of their school as not meeting the federal adequate yearly progress rating (Oregon Department of Education, n.d.) incurs administrative pressures that threaten the stability of the learning environment and, according to teachers, interfere with instructional goals, particularly in limiting the importance of middle school science (Fenyvesi, 2004).

Focus Group Students

Within the two 8th-grade science classes, eight students were chosen as participants for interviews and focused observation. The selection of the focus students was made with a combination of happenstance and deliberate selection. As I got to know the students I considered them as potential members of the focus group. I looked for a mix of the following characteristics among the group: race and gender, the researcher's evaluation of the student's degree of participation in class (confident and vocal, silent, or defiant), and the participating teacher's evaluation of their prior and potential academic success (the teachers in the school, including the participating teacher, commonly refer to students as "high" and "low") (Fenyvesi, 2004). The selection of diverse interview participants helped to prevent bias toward students who have good grades and may tend to participate vocally in class.

Additionally there were some students, like Andrianna, who would approach me with questions about what I was doing, or initiate conversations about

their lives. Because Andrianna was interested in what I was doing in the classroom, she became a candidate for the focus group.

In several meetings in early October, I showed Mark a preliminary list of the focus students. He offered his perspective on the students' level of interest and achievement in science class and in school in general ("high" and "low" students), and their personality (who likes to talk, who doesn't, who gets in trouble in school). For example, Andrianna was seen as a "very low" student who completed many assignments but struggled with reading, writing and analytical skills. She seldom spoke in class, was socially marginalized by other students and sometimes got into fights. However Andrianna loved to speak with some of the teachers such as Mark, and other adults like myself who visited the classroom.

I identified Terry as a potential focus student because he was a highly confident and outspoken African American male who did almost no homework and was failing many classes, including science. He spoke up in class to express his opinion but often resisted following the teachers' instructions. For example, Terry told me he did not do his homework because he did not like taking his science book home with him. Terry was put in detention several times for incidences (that I did not observe) in the cafetorium. Mark spoke of Terry as a "highly skilled student who does no work."

Tobi was suggested as a candidate for the focus group by Mark. At the beginning of the school year, Tobi could not stay in his seat for more than five or 10 minutes. He got out of his seat to poke other students with his pencil, push or

pull somebody's chair, make funny faces, and generally clown around. Mark characterized Tobi as "very low" and, when I looked at Tobi's written work, his handwriting and spelling made it difficult to decipher.

Tobi described his race is as mixed African American, Latino, and Native American. Though I personally found Tobi's constant joking and lack of consistent focus difficult to handle, within in a few weeks of the collaborative curriculum, he began participating in a focused way in class. Mark suggested that the interviews would be good for Tobi. Although I invited him several times, Tobi never came to an interview. He did participate in the KBOO radio lunch group which allowed me to spend time with him outside of class, build rapport and capture his perspective on many issues. Tobi was the only focus student who did not participate in the interviews.

Eshana was a mature, confidant but generally quiet African American female. Eshana would rarely speak out in class, always did her homework and got good grades. Mark considered Eshana a "high" student. She had a good sense of humor and sometimes joked respectfully with Mark. Eshana was part of a social group of African American females who did their work in class and at home, got good grades, and rarely got in trouble with teachers.

Seth was a quiet Latino male, who Mark described as "high." Seth seldom spoke in class, followed the teacher's instructions and often seemed interested in what we were learning. He told me that he liked to draw pictures and he submitted drawings depicting street scenes and the homeless for Street Roots newspaper.

Mark and I agreed that Latoya would be a great student for focused interviews and observation. Latoya was a highly confident African American female whose strong opinions and stubbornness got her in trouble with some of the teachers. Mark enjoyed Latoya and characterized her academic abilities and achievement as "high."

Ron was an outspoken Latino male who often came into science class without a notebook or a pencil and often got in trouble with teachers (other than Mark). When I spoke with Ron, he showed interest in environmental health issues and expressed himself openly and honestly. Ron loved to joke and was friendly with Terry.

Once I had selected, with Mark's help, Andrianna, Terry, Tobi, Latoya, Eshana, Seth and Ron, some of them arrived with friends to the interview sessions. Andrianna brought Gal, a very shy and, according to Mark, "low to average" female African American student, who joined the KBOO Lunch Group and became a focus student. Like Andrianna, Gal was socially marginalized. Unlike Andrianna, Gal was very shy.

The group of focus students who were interviewed and who were observed more closely in the classroom were: Terry, Ron, Seth, Tobi, Eshana, Andrianna, Gal, and Latoya. These eight attended CMS all year, were present for at least two interviews (besides Tobi), and several of them participated in the KBOO radio lunch group. I was able to closely observe and interact with these students.

Additional students participated in one or two interviews, they included Marty, Shatiqua, Juan, Iyola, Charlotte, and Sheldon. These additional students were included in the interviews, but not as focus students, for several reasons. After the first two interviews, in October and early November, I excluded those students who did not seem comfortable to speak openly with me during interviews such as Shatiqua, Jennifer, and Juan. Terry, being a leader in social groups of African American males, brought Marty, Sheldon and Jim to interviews, but I did not include them in the focus group because I felt comfortable with the number and diversity of the eight students that I had already chosen. Iyola and Charlotte expressed interest to participate in an interview late in my study. I felt that it made sense to interview them because it fit with the collaboration and empowerment goals of the study. By listening to Iyola and Charlotte I could show respect for their ideas and gain additional data.

The student research team was originally designed to include different students (three from each class) than the interview and focused observation group. I planned to choose these six students because, by the researcher's and the teacher's evaluation, they could offer insights into the culture of the students and classroom.

After my first set of interviews I realized that I would not be able to develop good enough rapport with a total of 14 students to make the interviews and research team meaningful for the study. I decided that informing the focus group students about my data analysis and asking for their ideas could offer richer

interview data, better member checking of data analysis, and a great opportunity to empower these students in substantive ways.

Overview of Data Collection and Analysis

My strategy was to collect and analyze data simultaneously. This linking of data collection and analysis helped to continually shape data collection and interpretation, and inform the cyclical action research process. Additionally, the linking of collection and analysis was critical in understanding the impacts of the curriculum, and making the curriculum responsive to the students' interests.

Data were collected two to four times a week when I was either with the students in the school or on field trips, or meeting with Mark. I took copious notes. Narrative descriptions from observations, interviews, and documents captured the perspectives of the participants often in their own words.

In order to assure data quality, data were analyzed using a combination of different interpretive approaches that offered a balance of a systematic approach and flexibility. Broadly speaking, data were analyzed to understand the students' and teacher's experience and perspective relevant to the research topics: student participation and learning, bridging personal and scientific knowledge, and empowerment in the context of our collaborative curriculum. All sources of data were analyzed using the same methods.

Data analysis was started during the first week of data collection and provided important information to shape the curriculum and pedagogy. For example, four weeks into data collection and analysis, I used axial coding (looking

for relationships between codes) to reveal the connection between recurring codes around student social safety and student silence. After checking my analysis with the teacher, we decided that to increase participation we needed to take steps to make the students feel more comfortable with one another, and thus more able to take the social risk that speaking up in class represents for many students.

True to the complex reality of qualitative action research, the week after we discussed forming more friendly class communities, the school administration decided to rearrange all eighth graders into new classes. The teacher remarked how much harder the reconfiguration of classes would make our work on building community among students. Some shifting in interview students occurred with the rearrangements of classes.

Student Interviews

The student interview protocol is provided in Appendix A. Interviews were conducted around a long table in the science classroom during the lunch period. In order to make the interview logistically feasible given the short lunch period – so that students would not have to wait in line at the "cafetorium," as the cafeteria is officially called in the school – I ordered pizza for the interviews. The pizza obviously served as an incentive for students to come to the interview and forfeit their only free time of the school day, particularly for the first interview when students were not yet comfortable with my role.

Nine student interview sessions were conducted over the course of the study and a total of 16 students were interviewed. Two mixed gender interview session

was conducted, three with only males, and four with only females. Each interview session included 2-5 students and lasted approximately 30 to 45 minutes. The table below provides a numbered list of all the interview sessions, and the names of students who participated. Names of the eight students in the focus group appear in boldface. When I present data in the form of student quotations from these interviews, I reference the interview number in this table.

Table 2

Interview Sessions and Participants

Interview Number	Date	Participating Students
I1	10/13/04	**Seth**, Shatiqua, Eshana
I2	10/20/04	Don, Marty, **Gal, Andrianna**, Juan
I3	12/9/04	Jennifer, Eshana
I4	12/10/04	**Andrianna, Gal**
I5	1/13/05	**Seth, Terry, Ron**
I6	1/26/05	**Andri, Gal**, Eshana, **Latoya**
I7	2/22/05	**Ron, Terry, Seth**, Sheldon
I8	2/23/05	**Ron, Terry**, Marty, Jim
I9	3/06/05	Iyola, Charlotte, **Latoya**

In my October interviews that included boys and girls, I found that the boys responded to my interview questions while the girls barely spoke at all. For this reason, after October, remaining interviews were conducted with boys and girls separately. I was also careful to group those students together in interviews who I thought were comfortable enough with one another to have a conversation. For my last interview groups I found that asking one or two students and asking them to invite two or three of their friends provided a cohesive social group that made for open and lively conversations.

All students who were interviewed had turned in consent forms signed by them and a separate consent form signed by their parent(s). Before the interview I spoke with students about what I was doing in the school and what my goals were. I reminded students that they were not required to participate and could end their participation in the interview at any time. I told the students that I would not use their real names when I recorded what they said, and that their comments would not affect their grades in science class.

Interviews were audio-taped using two tape recorders simultaneously, one main recorder with an external microphone and small recorder as a back up. The students were excited about the external microphone and enjoyed moving it toward the student who was speaking next, holding it, or passing it between them. The microphone added some legitimacy and excitement connected with the students' excitement about media (several students used gestures or terms borrowed from television in conjunction with the microphone). There was one interview that was not audio-taped due to problems with the recorder. However, copious notes were taken at this interview.

Because of my role as an adult authority and the social dynamics of an interview, at the first interview I felt that the students were giving me answers that they thought I would like. I encouraged students to disagree with me and to tell me exactly what they thought. I emphasized again and again that I did not grade them, did not inform the teacher about their responses, and needed their ideas for my

work. Additionally I reworded some of the questions to make them more open and less evaluative.

For example, one of the questions on my original student interview protocol was: "Do you think it is important to study stuff that's going on in your neighborhood? Why or why not?" Students always said yes to this question but seldom offered much insight into what the curriculum meant for them. In the middle of my second round of interviews I replaced this question with, "How is studying about community environmental issues different from other things you have done in science this year of last year?" This more focused and more open question encouraged the students to describe our curriculum in ways that made sense to them and allowed them to critique our curriculum in a safer, less direct way. I also added questions such as, "What has been your favorite activity? Why?"

In my fourth interview, I asked Andriana and Gal what they thought of a video made by middle schoolers that I had shown them. When Gal, usually shy and hesitant, replied loudly and clearly, "It was kind of stupid and boring," I knew I was getting more honest answers.

In addition to asking interview questions, I posed scenarios to the students about student participation such as, "Let's say you are the teacher. How do you encourage students to participate?" I also checked my data analysis with students using questions and scenarios like this one.

Teacher Interviews

Four structured interviews (using the protocol in Appendix B) were held with the teacher. The purpose of these interviews was to: cultivate our collaborative relationship, get the teacher's perspective on the curriculum, student participation, bridging, and empowerment, as well as on my findings. These interview sessions lasted between one and two hours and were conducted on the following dates: October 8, November 9, January 16, and February 2. Additionally, several times a week, the teacher and I held conversations about the curriculum, logistics, the students, and the research. Notes on these conversations were taken either as we talked in person or on the phone, or soon afterwards.

For example, in early November, the teacher and I flew to Mississippi to present our research at the North American Association for Environmental Education conference. Preparing for the presentation, reflecting on it, and talking about other presentations we attended offered invaluable thinking and planning time for us. These conversations are recorded in my extended data log as well.

Both teacher and student audio-taped interviews were transcribed within 48 hours of the interview so that contextual details could be recalled and recorded in the data log. Interviews were transcribed into the same extended field log format as was used for observation notes and document analysis. Transcriptions were verbatim except for portions of interviews that veered far away from the study. These were summarized in parentheses in the log. During interviews, hand written

notes were taken on who was sitting where, student facial expressions, body language, and other relevant context.

Observation

Observations were conducted in the science classroom, on field trips, and occasionally in the hallway or "cafetorium." Forty-five observational sessions were conducted between September 2004 and March 2005, and that each covered one school day including usually two 55-minute science class periods. The majority of observation time was during the planned curricular innovation – investigating and acting on community environmental issues – during sixth and seventh periods, between 12:40 and 2:55 p.m. However to gain contextual data, some observations were made during class time devoted to other curricular units in science.

For convenience of scheduling observational times and to be able to build rapport with students, I chose two 8th-grade science classes containing approximately 55 students to be the participants in the study. The two classes I chose met fourth and sixth periods, adjacent times in the school day. This meant that I did not need to remain at CMS all day, but rather visit for 3-4 hours a day. I occasionally observed periods seven and eight. I felt that I could not spend in enough time in all four classes and build good rapport with more than 100 students. Observations in the "cafetorium," teachers' lunch room, and hallways provided important context for the study.

When conducting observations, I took copious written notes on what the teacher was doing and what students were doing, particularly the focus students. I

paid special attention to the teacher's and students' comments and questions in class. When I could capture students' and the teacher's statements accurately, I recorded them in my notes in quotations. In this dissertation, student quotations that come from interviews are followed by an "I1-I9" in parentheses to denote which of the interview sessions the quote comes from. All other quotations in this dissertation come from observational data. An example of observational data in an extended data log is in Appendix C.

During classroom observations, I would alternate between sitting, watching and writing notes, and walking around the room, helping students, passing out papers, etc...I would often change seats, sitting at empty spaces next to, or across from students, or on the side of the room.

At times I would present information from the front of the classroom or serve as the recorder for class brainstorming. On field trips I had the role of chaperone. At times I helped students with the finicky locks on their lockers, or found paper and a pencil for them. These various roles fit with my stance as a participant observer in an action research study (Fine & Vanderslice, 1992). I agree with Angrosino and Perez, (1998) who argue that the ethnographer is a collaborator. I did not see the students as subjects but as partners. These different activities were an important part of both my role as a researcher-curriculum writer-collaborator with the teacher and my role as a qualitative researcher, gaining a multiplicity of perspectives on what was happening in the classroom.

These various activities were crucial in being able to develop rapport with students and position myself as an ally rather than simply an adult authority figure. In other words, I worked hard to assure the students that I was in the class to understand and help them rather than to assess or discipline them. On several occasions while I sat next to students doing observations and taking notes, a student asked to see what I was writing. I always showed the students my field notes and reminded them of my purpose: to figure out how to make connections between science class and community and to figure out how to teach science better.

Documents

Documents were collected and analyzed to understand the connections students were making between personal/cultural knowledge and scientific knowledge, and to understand student learning of scientific concepts. The documents, all student assignments that we designed for our curriculum, served as both research data and learning assessment and grading data. Most of these assignments were completed in the classroom, but a few were homework assignments. Many of the assignments were brief entries in the students' "Science Journal" section of their notebook. Students wrote in response to questions that the teacher and I framed. The students were told that journal entries were not graded by the teacher but they got credit for writing down their thoughts. The following documents were collected from approximately 55 students in the two classes that were the participants in this study:

- Science Autobiography: 9/15/04, 2/10/05
- Journal entries: "What community science issues would you like to learn about?" 9/29/04. "What is your community?" 10/15/04
- Science/vernacular glossary: 1/15/05
- "Get to know your neighborhood": 10/27/04
- "Your thoughts on Erin Brockovich": 11/23/04
- "KWL ('what I Know, what I Want to know, How I am going to Learn it') on Community Environmental Project": 12/8/04
- Student poems and articles in Street Roots newspaper: 2/15/05, 3/10/05

One additional written document was collected, a written feedback form from the teacher. This feedback form contained questions about the research collaboration as well as a few of the interview questions. The teacher turned in this form in early March.

Although I analyzed student documents of all 55 students, analysis focused more intensely on the eight students who were interviewed. As a whole, I found written assignments to be poorer data sources than observation and interviews. On the basis of my findings that I discuss in chapter 5, I concluded that most students felt more comfortable expressing themselves orally than in writing. The exceptions to this pattern were the articles and poems many 8th-grade students wrote voluntarily for Street Roots newspaper.

Second Observers

I originally proposed to have a second observer visit the classroom six times during the study. Second observers offer additional perspectives for triangulation of data and serve as a check on researcher bias. I found that the complexity and time demands of the study, including planning and analysis meetings with the teacher, changes in the school schedule, as well as busy schedules of prospective observers, made six visits impossible.

I chose two doctoral students with whom I had worked to act as secondary observers. These were people who knew the history and context both of my study and of the school. I spoke with the doctoral students before their visit to the school about the focus of the study and their particular role in it. However, because of time constraints, only one doctoral student, visited as a second observer. This student visited the classroom three times during the study: December, January, and March.

After the observer came to the class, we sat and reviewed notes. I took written notes from this meeting and added them to my extended data log in the form of raw data and memos. I found that the observations of this secondary researcher helped in offering a perspective different from my own. She pointed out things I had not noticed, contradicted some of my observations and confirmed some of my analysis, and opened paths for new analysis and new modifications to the curriculum. For example, she pointed out interactions between students and student comments that I missed. She also had insightful observations of the tensions in Mark's pedagogy between a student-centered, social constructivist approach in line

with our collaborative curriculum, and a more behaviorist, teacher-centered approach.

Data Analysis Process

Data was analyzed by a progression of coding methods. Miles and Huberman (1994) write, "Coding is analysis. To review a set of field notes, transcribed or synthesized, and to dissect them meaningfully, while keeping the relations between the parts intact, is the stuff of analysis" (p. 56). Codes are labels assigned to pieces of data to carry certain meanings in the data. The progression of coding outlined below moves from more specific and discrete meanings attached to individual words or phrases in the data to overarching themes that are reflected in multiple codes throughout the data.

Based on the recommendations of Miles and Huberman (1994) and Strauss and Corbin (1990) I used the following process for data analysis:

- Codes developed from my pilot study and the literature helped to sensitize me to the data (Miles & Huberman, 1994). This is a partial list of a priori codes I started with: the tensions between discourses of home and school (Delpit, 1995; Barton, 1998), student participation and respect (Tobin, 2000), relevant knowledge and power, and talking versus doing (Fenyvesi, 2004).
- Microanalysis and open coding were used to develop codes and label them within the data. These methods involve meticulous examinations of small portions of data (such as short phrases). Labels were attached to

relevant portions of field notes, transcripts and written documents, separated from the text by "~" or in the margins of the text (i.e., ~ CORAN for "correct answer" code). Some quotations from the data such as "sit and listen" became codes.

- A list of codes was kept and continually revised with new or changed codes citing where the code was linked to the data (i.e., STSIL: Student silence, pp. 15, 12-14, 19, 30-32).
- Through axial coding the relationships between the different codes was documented. Axial coding involves looking at two or more codes together to see how they are related. In this process, two related codes were collapsed into a single code, or an entirely new code or even theme was developed on the basis of relationships between initial codes (see Appendix D).
- Selective coding was used to integrate and refine codes and to develop themes. In this process I selected codes most relevant to my research questions and looked at the entire list of codes as a whole. At this point in the analysis, some codes already described broad themes, others were strung together to form a theme, or narrative.
- Three times during the study, the participating teacher read portions of my extended data logs with coding. He made written comments on the data log and we discussed codes and themes. Additionally, I checked

my data with several Portland State University faculty members on three occasions during the study.

- Themes were described and tested for fit against the data. Reading and rereading the data while reading relevant literature helped in all steps of data analysis by confirming, contradicting or offering a new lens on my analytical perspective on the data.

These particular methods for data collection and analysis (extended field notes, the use of memos, microanalysis, etc…) were chosen because they offered systematic methods of collecting and analyzing data in a cyclical way. I became familiar with these methods during the pilot study and found that the methods provided a map of what methodological or analytical decisions were made in data analysis. This way the choices made by the researcher can be followed and examined by other researchers (Strauss & Corbin, 1990).

For example, early in the study I developed the code "STSIL" (student silence) to describe when a student did not speak for during classroom conversations. This code was attached to pieces of data in the extended data code when students did not speak, or try to speak (by raising their hand) for a whole class period in which they had multiple opportunities to speak. On the basis of several pieces of data including this quotation from interview #3, "Kids don't talk because maybe the popular kids laugh at them," I developed the code "STSILFEARPEER" (student silence because they fear peers laughing at them). I attached both the code "STSILFEARPEER" and the code "CORAN" (Students

believe in correct answer) to this quotation, "Popular kids might laugh because they got the wrong answer." To the following piece of data "Tobi offers a survey question and then looks at class and says "ooh, looks who's smart now," I attached a new code "BEINGSMART" (importance of seen as being smart in class).

Through axial coding, I examined the relationship between these four codes: STSIL, STSILFEARPEER, CORAN, and BEINGSMART. From looking back at the data attached to these codes, I concluded that two connected reasons for student silence were: (a) that students believed there was a correct answer to questions the teacher posed, and (b) that students were afraid of being laughed at if they got that answer wrong.

Using selective coding on the four codes above together with the codes STSHAMECMS (students express shame about CMS), WORDRACISM ("word racism": being mistreated/disrespected because of the words you use), STEXPRESSPRIDE (students express pride in selves, or neighborhood), and others, I saw that they overlapped strongly around the theme of respect: being respected or disrespected by peers in class, feeling disrespected by the public by being a student at CMS or using certain language, and feeling that one's neighborhood deserved respect. The theme of the respect, together with the themes "sit and listen," "shake it out yourself," student resistance, and competing languages, were the basis for my conceptualization of the narrative of the "Empire of School and the Small Student Nation" that I use in my Findings and

Recommendations chapters. Additional examples of data coding are in Appendix D.

Extended Data Log

All data were transcribed (usually within 48 hours) from written notes or audiotapes or documents to an extended data log in Microsoft Word. The data log had dated pages of data with each line numbered for easy reference and wide right margins for making notes, coding, etc. After each entry, which usually represented one day of data, I wrote memos. These memos were titled either "analytical" for general analysis and coding, "methodological" for notes affecting research methodology, or "theoretical" notes relating data to theory from the literature. Each entry had analytical memos, but methodological and theoretical memos were used less frequently. See Appendix C for an example of my extended data log.

Approximately every 10 days, the extended data logs were printed out so that they could be reread and analyzed in a different setting (not on a screen) and by the teacher, faculty or doctoral student second observer. Notes made on the pages were then typed into the log on the computer and dates added to new and revised codes, or new pages started titled "reflections." Reflection pages within the data log were a place for challenging my assumptions and analysis. I looked for contradictions in my data, came up with new perspectives on the analysis, or reflected on my roles and lessons as a beginning researcher.

Time Frame

The time frame for the data collection and analysis was approximately six months, late September through the middle of March. However, the pilot study conducted the previous year in the same teacher's classroom enabled me to gain access to the school, build rapport with the teacher, and get to know the school and classroom context. Additionally, the teacher and I began planning the curriculum toward the end of the pilot study. Without the benefit of the pilot study, neither the complex and effective collaboration nor the collection of meaningful and rich data would have been possible in six months.

Human Subjects approval was received in August 2004 and signed consent forms were received for the teacher and the majority of students by the second week in September. In the first two weeks of March, I conducted my last observations and interviews. My last day with the students at CMS in March was a celebration of the community environmental health project. We listened to the students' KBOO radio program, students read from their poems and articles, Mark and I thanked and congratulated the students, and we ate and drank. This was a great way for me as a researcher, activist, and student ally to say goodbye.

Ethical Issues

I concur with Ely et al. (1991) who write that all research involves ethical issues. The ethics of this study are embedded in the specific questions of informed consent, identity protection, researcher roles, subjectivity, and bias.

Informed Consent

Guidelines of Portland State University's Human Subjects Research Review Committee were followed. Consent forms were obtained from the participating teacher, from parents/guardians of students, and from students themselves. Consent forms described the study and the data collection: observation, interviews, and document analysis.

A list was kept of all consent forms that had been received and who was missing which forms. Students for whom parent/guardian consent forms had not been received were given another form to take home. If these additional consent forms were not received, those students were not interviewed. If student consent forms were missing, I gave the students the forms before interviewing and if they gave consent, they were interviewed. Before student interviews I reminded students that they were not required to participate and whatever they chose would not affect their grade, my relationship with them, or their relationship with the teacher.

Protecting Identity

All students and the teacher received pseudonyms. I maintained a chart that matched real student names with pseudonyms. I kept this chart and audiotapes of interviews in a locked drawer. Additionally, the school was given the pseudonym "Columbia Middle School" which I use throughout this dissertation. All student and teacher names used in this dissertation are fictitious.

However, I tried to give student pseudonyms that did not erase their cultural identity. Many student participants in this study, particularly African American and

Latino students, have names that expressed cultural and/or religious identity. Rather than renaming (this is a fictitious example) "Latosha" and "Jesus," "Susie" and "John" I gave them the pseudonyms "Yolanda" and "Juan."

Researcher Roles

An action research collaboration that uses qualitative methods demands that the researcher attend to multiple roles (Fine & Vanderslice, 1992). Reflection on and discussion of the researcher's role, ethical conflicts, and personal assumptions and bias are central to insuring data quality (Lincoln & Guba, 1985). Below is a list of roles and related activities the researcher played at various times throughout the study (see Table 3).

Table 3

Researcher Roles and Activities

Role of Researcher	**Activity**
Ethnographer	Observing, interviewing
Curriculum Developer	Planning, researching, learning activities
Curriculum Evaluator	Analyzing data, talking with teacher
Teacher	Researching and presenting information, facilitating discussions, helping students one-on-one and in small groups
Student Ally	Listening to students, helping them with work, mediating student disputes
Professional Developer/Colleague	Facilitating own and teacher reflection through data analysis, planning
Adult Authority Figure	Ensuring student safety, field trip chaperone
Community Liaison	Contacted scientists, doctors, community activists for field trips, class visits

Conflicting Roles

The most difficult and significant conflict I faced was in responding to conflicts between students and maintaining good rapport with those same students, being an ethnographer and ally to students, and being an adult authority figure who could ensure student safety. There were several occasions when ethics came into play in issues of student safety; I felt that I needed to use my authority as an adult to stop harassment in the classroom. However, I also understood that by exercising my authority, I could potentially lose the trust of some students.

Generally, when students approached me with disciplinary problems ("he pushed me") I told them to talk to the teacher as that was his job, not mine. "I am here to help you learn science in the community," I would remind them. Only a few weeks into the school year however, this tidy role delineation I had established was challenged. On several days when the teacher was absent from school for personal reasons, we decided that although I could not act as an official substitute (I lack teacher certification), I would teach the class nevertheless. The participating teacher told me that because of my rapport with the students and my involvement in the curriculum, the students would learn more if I taught in place of the substitute. On these days I dealt with a wider range of teacher activities: I asked for students' attention, I responded to requests for students to go to the office, I reprimanded students for inappropriate behavior.

One day in the fall, while the students were working in table groups on defining community, Hally called me to their table. She said to me, "Gerry is

harassing Loretta, but she is too shy to tell Mr. Mark." I encouraged all the students at the table, and Hally particularly, to speak with Mr. M about discipline issues. Hally quickly replied, "But you are an adult. You have authority."

I told Hally I agreed with her, and told her I would talk with the teacher about it. I stayed for the remainder of class close to this table to assure Hally that I had listened to her, and made my own observations of what was happening. I saw no harassment for the remainder of the class period. However, from what I knew about Gerry and Loretta, Hally's story could have been true. I decided to speak with the teacher about the incident after class.

There were several instances when I saw boys physically or verbally harassing female students. When I thought my intervention would help resolve the harassment, I intervened. I spoke with both students about what I saw and always spoke with the teacher after class about my observations. I considered confronting harassment to be part of ensuring the students' safety, a role very different from asking students to pay attention.

There were also some less serious incidents that helped me to refine my role and communication with students. One incident in particular helped me to change my approach. The teacher left the classroom for a few minutes to speak with another teacher. The students were sitting at their desks making maps of their neighborhood. One student, Marty, got up from his seat and started walking around the classroom. I asked him, "What are you doing?" Marty quickly replied indignantly, "You saying I'm not doing my work? I did it and erased it!" Not only

did this interaction build friction in our relationship, but with Marty defensive and a little angry, I was not able to understand why he was walking around or what he was thinking about the mapping assignment.

After this incident with Marty, particularly when a student was busy with something besides the learning activity (walking around the room, poking another student with a pencil, brushing their hair) I asked them, "How's it going?" instead of "What are you doing?" I found "How's it going?" or "What's up?" to be much less threatening questions that would help me both maintain rapport with students, gather data (what were they doing and why), and help them to learn.

Subjectivity and Bias

I believe that a researcher must be conscious of personal bias and discuss it explicitly in writing about the study. This means the researcher should describe in detail the steps that were taken to gather and analyze data, should be dedicated to gaining multiple perspectives on the data, and must develop awareness about his or her biases. In this study my biases are the following: idealizing students as victims of an oppressive system, perceiving all data to be a confirmation of my beliefs about science education and the success of our collaborative innovation, and using my observation data to evaluate according to my expectations rather than describe.

This study is embedded in my identity as an environmental and social justice activist, as a European American, and as a doctoral student. Because of my progressive white educator bias, it is easy for me to see the students and teacher as victims of an unjust system, rather than as powerful actors in a complex web of

relationships. On the other hand, it is also easy for me as an idealistic educator and doctoral student to slip into evaluating rather than describing students' and particularly the teacher's behavior. Reading the relevant literature and having conversations with doctoral students and university faculty helped me to continually uncover and confront my biases.

My belief that science must incorporate student knowledge and interests could have led me to find only data that confirmed the success of this approach. In other words, I could have used this study to prove that marginalized 8th-grade science students participate more fully and learn much more when the curriculum encourages them to bridge personal and scientific knowledge.

However, at the same time, my commitment both to social justice, and to the teacher and students with whom I worked meant that rather than try to prove a point for my own benefit, I strived to be honest, accurate and fair in my study. Only a study that is thorough and trustworthy will serve the students at CMS and contribute to the work of teachers and researchers. Additionally, many steps were taken in data collection and analysis to verify trustworthiness of the study.

One example of my assumptions and initial analysis being challenged involved the students' very lukewarm response our initial question on community environmental issues. Mark and I assumed students would be excited to brainstorm and discuss environmental issues in their community and therefore tried this as one of our first activities. Few students joined this classroom discussion to generate ideas, and when I approached Jennifer individually she responded curtly, "We ain't

got no issues." In my initial response and analysis, I questioned the students' ignorance and resistance to our attempt to engage them in a more collaborative learning activity.

However, after speaking with Mark and Portland State University (PSU) faculty, I realized that the students' response may have more to do with language and lack of context for the question. One PSU faculty member suggested that the students may have felt threatened or even insulted by the negative implications of issues and their feelings of community pride. My initial analysis was hasty and superficial, and clouded by my attachment to my own way of framing community environmental issues. As a result of rethinking this incident, Mark and I decided to (re)start by defining community, looking at city maps, and designing with the students a neighborhood survey.

Trustworthiness

I used Creswell's (1998) four methods for verifying this study as well as a fifth method conceptualized particularly for action research:

1. Clarification of research bias: Throughout the study and in this dissertation (see 'Subjectivity' above) I reflected on my bias and how it might affect the study.
2. Member checking: In student and teacher interviews, I asked questions regarding interviewee's comments, and presented my data analysis for comment.

3. Triangulation: Data were triangulated by using multiple data collection methods: observation, interviews, and document analysis.
4. External Audit: One second observer who was familiar with the setting and study offered her perspectives on classroom observations as well as data analysis. Susan Stein, my advisor, and other faculty provided additional audits by listening to and reading my analysis, offering questions, and asking for clarifications.
5. Greenwood and Levin (1998) write that the validity of action research is measured by the "workability of the actual social change engaged in" (p. 96). I know that I helped to catalyze change in the classroom, helped empower students in science class, and offered Mark significant support in his professional development.

Limitations

The most significant limitations of this study were my limited experience as an educational researcher, time constraints for teacher planning time and instructional time, the short duration of the study, instabilities at the school, and methodological limitations.

Because of personal issues and the nature of teaching at CMS, the participating teacher's time was more limited than either of us had expected. As a result, at times, data analysis and curriculum planning were rushed. Additionally, our curriculum was in constant competition with the mandates of the district curriculum. Instability at the school meant that our planning meetings, and

sometimes instructional time, were cut short because of last minute changes at the school.

The pressures of time and the school context meant, for example, that I abandoned my plan of having a research team of students separate from the students I interviewed. Additionally, on several occasions students who I chose to interview got in trouble in the hallway or cafetorium and went to detention instead of the interview. Even though the pilot study allowed me to get acquainted with the school and teacher, a study that lasted several years would have yielded better data and allowed for time to follow up many of the questions that emerged during data collection and analysis.

Some of my methods served to limit the data I was able to collect. For instance, although I attempted to choose a diverse group of students to interview, often certain students were detained for breaking various rules in the cafetorium, or did not show up for other reasons. However, it was clear to me that the opportunity to talk with me and eat pizza did not, for some students, outweigh the other opportunities during lunch period.

There is a good chance that the students who actually showed up for interviews were a more select group than I had intended. Were those who showed up for interviews more academically motivated? Less likely to get in trouble with the administration? Less interested in socializing with peers at lunch? More interested in pizza? What about those who consistently were in detention so could

not attend lunchtime interviews? These logistical and methodological limitations were embedded in the context of the school and study and not simple to solve.

Conclusion

This chapter describes methodological choices and their rationale. Based on the research questions and context of the study, qualitative methodology and action research design were chosen. The selection of the site, a Title I middle school, and the participants, 8th-grade low-income mostly African American and Latino students and their African American science teacher, were described.

Between September 2004 and March 2005, data collection and analysis were conducted concurrently. This linking of data collection and analysis helped to continually shape data collection and interpretation, and inform the cyclical action research process. Data were collected by observation, student and teacher interviews, and written documents. Data were analyzed to understand the students' and teacher's experience and perspective relevant to the research topics: student participation and learning, bridging personal and scientific knowledge, and empowerment in the context of our collaborative curriculum.

I discussed steps I took to insure the quality of the data and to control bias: multiple data sources, a second observer, member checking of data analysis, and an examination of my various roles and personal bias.

CHAPTER V

FINDINGS

Based on my experience and the literature described in chapter 2, I conducted a study in which the participating science teacher and I collaboratively designed, implemented and evaluated a curriculum that solicited students' knowledge in the investigation of and action on community environmental issues. Qualitative methods were used to collect and analyze data to answer questions on student participation, bridging of personal and scientific knowledge, and empowerment inside and outside of class.

This chapter offers the answers to the research questions that guided the study. In qualitative studies, research questions are meant to focus but not limit the study. Not all questions that guided this study yielded rich findings. In this chapter I focus on the most compelling findings, and, in addition to the data that directly addresses the research questions, explore themes that emerged from the data on the teacher's and students' views, language, and learning.

The research questions that guided the study are:

In a collaborative curricular and pedagogical innovation that elicits student knowledge about their communities through investigation of and action on community environmental issues,

1. How do students participate in the learning activities?
    a. Do students offer ideas in response to open-ended questions? Do students offer unsolicited comments, questions or ideas?
    b. What forms of non-participation are expressed by students? Why?
    c. Do students talk about what they are learning with their friends and family? Why or why not?
2. How do students bridge personal/cultural knowledge to scientific knowledge?
    a. In presentations and other curricular activities, do students connect scientific knowledge with personal or cultural knowledge?
    b. What aspects of the curriculum and pedagogy help them to bridge these forms of knowledge?
3. Does the collaborative curriculum help to empower students as science learners and community members?

Research Question 1: Student Participation

This section describes aspects of student participation such as: the teacher-solicited and student-initiated comments, reasons for student silence, the significance of students talking about science outside of the classroom, and the teacher's view on how participation changed as a result of our collaborative curriculum.

When I started my research in the classroom, I planned to observe student participation as public academic talk, such as things students said to one another or the teacher that concerned the subject matter. I thought that recording which

students said what and how often they spoke, or remained silent, would give me insight into student participation, bridging and empowerment. However, after my first days of collecting data I realized that this view on participation could not capture the complexities of what was happening in the classroom.

In my first analytic memo in my field notes on September 20th, I wrote: "So much of whether the student talks or not – public academic talk – depends on how the teacher is teaching." On October 10th I wrote: "The way I structured my research question on participation was too isolated, not looking at system, culture, dynamics." I quickly realized that a complex web including social norms, the teacher's and students' perception of school, and the structure of the lesson shaped participation in the classroom.

This realization inspired two specific curricular and methodological shifts. First was an effort to change the dynamics of the class by providing students with choices in the curriculum and trying to shift student norms of participation, and by offering many ways for students to participate besides responding to the teacher's prompts. Secondly, I started to place more emphasis on the different contexts in which students spoke up and what they said. Data on student initiated comments, and students speaking about learning with family and friends, became more compelling because it spoke to issues of bridging and empowerment. Additionally, later in this chapter I address issues that affected student participation, such as the tensions between the teacher's and students' views on school, science and language.

Research Question 1a: Student Initiated Participation

The day after students completed their neighborhood surveys, Mark asked the students to share their findings. In the middle of this sharing, Sheldon raised his hand and asked, "Mr. Mark, can you get cancer from the environment?" A brief discussion followed Sheldon's question, with a few students offering ideas. During the talk by the Lewis and Clark professor, several students made unsolicited comments adding to what the professor was saying about detecting pollution in their neighborhoods. Kolata raised her hand and said, "I live up the street and there's lots of buses. Would it help if I said I smelled gas a lot?"

In the class that chose to study homelessness, students offered many self-initiated comments during a visit by a homelessness activist and in response to reading Street Roots. While students read from Street Roots newspaper, Latoya raised her hand and asked in a deeply concerned voice, "Is somebody going to help the homeless? The government? Where they gonna go if it snows?"

I believe that unsolicited comments like these are significant for several reasons: (a) they show student motivation and empowerment, (b) they offer insight into what students are thinking about and especially how they are making sense of what they are learning, and (c) these comments are often a sign that students are bridging the science learning into their own world.

As the collaborative curriculum progressed, more students engaged in participation unsolicited by the teacher. Most class sessions (50-minute periods) in January had 3-5 student-initiated comments in each session, compared to the class

sessions in October and November that had 0-2 student-initiated comments. This study was not designed to prove that changes in participation occurred for certain reasons, but rather to explore student participation in the context of the collaborative curriculum, bridging and empowerment. However I can point to several factors that were related to student participation, and specifically student-initiated comments. These three class sessions in January dealt with public aspects of the curriculum, the neighborhood surveys, and visiting speakers (a professor of Environmental Studies, a homelessness activist). Additionally, as I discuss in this chapter, we shifted student norms around the right answer and peer ridicule that made the classroom a safer environment for students to speak out.

Research Question 1b: Forms of Non-Participation

There were many forms of non-participation expressed by students, such as reading a book or drawing during a discussion, but the most compelling data led me to look specifically at reasons students were not speaking out in class. Because I was interested in forms of verbal participation, I looked at non-participation as silence. Here I briefly describe silence in the class and the reasons we found for that silence.

Particularly in the first weeks of the study, few students offered answers or comments to Mark's questions and students very rarely initiated comments. In these first weeks there were no class discussions that involved several students offering comments of questions. Mark would ask a question and one student would offer a response, then Mark would ask another question. There were several

students in each class, such as Gal, who I did not observe participating verbally in class learning for the entire study. In other words, there was much silence.

One of the first successful uses of our action research methodology (research data continually informing the teaching and research) centered on the issue of respect and speaking in class in front of peers. In my third interview session, I asked students why they and their classmates were often silent when the teacher asked a question. Jen promptly replied, "Popular kids might laugh because they got the wrong answer." Eshana added, "Make yourself look bad" (I3).

As a result of students' comments, Mark and I decided that he should discuss the issue openly in class to create a safer environment for students to speak their minds. When he asked the students why they didn't speak up in class, he got a barrage of almost identical responses. Sara answered, "People make fun of you." Marty added, "You get put down," and Andri suggested, "You feel kinda embarrassed."

Mark and I observed that in the particularly silent 4th-period class the boys and girls who spoke often were socially marginal or independent types, not those in the center of the social groups. We thought that these socially independent or marginal students did not fear being embarrassed in front of their peers. For the majority of students this fear had a huge influence on student participation.

As part of planning the presentations for second, sixth, and seventh graders, the students voted on whether to present in front of the whole class or to present in small groups (three eighth graders teaching 2-4 younger students). In each class,

75%-85% of the students voted to work in small groups. The students saw far less risk in the small groups.

Issues of respect, shame, and pride were also central in students' perception of their school and neighborhoods. Lon wrote in a homework assignment, "My community is clean and not clean at the same time..." Latoya wrote, "My community has a lot of violence. Is also my favorite place to live." Paolo once suggested that on a field trip, the students should not say that they are from CMS because people will think poorly of them.

In their research, Seiler (2001) and Tobin et al. (1999) found that students' struggles for respect from both peers and teachers were a defining dynamic in the classroom. At CMS I found that the students' yearned to earn respect in front of their peers and the larger community. This was one of the reasons almost all the students were excited about parts of our program that involved public presentations. Many students said their favorite part of the program was doing student-designed neighborhood surveys that involved asking neighbors questions about the environment and health concerns. More students turned in the neighborhood survey (as homework) than any other assignment of the school year.

The risk of being disrespected in front of the class is closely linked with the idea that the teacher's questions have right answers. The students' discomfort with answering the teacher's questions did not seem to depend on whether the teacher asked a closed or open question. Whether Mark framed the question as "What do you think about the video?" or "How can we investigate neighborhood issues?" the

students thought that there was one right answer that Mark was expecting. On several occasions, students raised their hands tentatively to answer a question and asked, "Can I guess?" or "Is guessing O.K.?" Latoya, an outspoken African American student paused before offering her comment, "What happens if it's not right?"

When the students had opportunities to ask each other questions, they almost always asked closed questions. These are questions that, by their structure, had a right and wrong answer. After reading articles on community environmental health issues in Northeast Portland neighborhoods, student groups did presentations on the articles. When they asked the audience questions, students invariably used closed quiz-type questions about percentages or amounts of pollutants. It was clear that students were seeking the "right answer" whether they were asking or answering the questions in class.

To give students ways of participating outside of class, and to amplify student voices, I brought in a young, experienced radio reporter from KBOO community radio to work with students during lunch. A small group of students chose to participate (pizza and radio fame were the only enticements) and record a short radio program on what they were doing in science class. The KBOO reporter suggested that students try the medium of "Vox Pop" in which they ask dozens of people in the school to respond to a single open-ended question. The reporter played a Vox Pop she had recorded weeks before in which she asked a "What do you think about" type of question.

However, in two 30-minute brainstorms, the students came up with closed questions that sounded as if they came from a textbook: "What part of Portland is the most polluted?" "How many people die from asthma?" "Which city is the dirtiest?" The students' plan had been to do a "Vox Pop" with CMS students. However, after looking at the list of questions they developed, Paolo suggested, "We should ask smart people." Delon added, "Yeah, we should ask someone who traveled," and Terry offered, "We should ask the teachers." The students had a low opinion of their own knowledge. They assumed that if schooling is about having the right answers to factual questions, then the teachers are the ones to ask.

Blumenfeld, Soloway et al. (1994) found that the idea of error as failure – held by students and teachers alike – was a deeply entrenched obstacle in shifting to project-based, constructivist learning. They recommended that teachers help students redefine mistakes as "adaptive," as sources of learning and success, not failure.

After two months of experiencing our collaborative curriculum, I did not hear students ask whether guessing was OK, or what were the risks of getting it wrong. From my data on student-initiated comments and Mark's perception, for some students, participation in class discussions increased after the first few weeks of the program, and generally stayed high throughout the program.

Although Mark was at times ambivalent about the kinds of questions and the kinds of knowledge that were most valuable in class (see "Hard Science" discussion later in this chapter), I believe that we managed to shift to a classroom

culture with less risk of losing face, and with more space for student knowledge and language, curiosity, and open discussion.

The power of the "right" answer diminished as students gained expertise in making observations in their neighborhood and were encouraged to value other sources of knowledge besides books and the teacher. Additionally, openly discussing student fears and urging respect, allowing students' language into the classroom, and offering multiple sites for expression (class discussions, interviews with the researcher, KBOO radio show, articles and poems for newspaper) created a classroom where many ideas and answers were valued.

Research Question 1c: Talking Science After the Bell

Some of my richest data on participation, bridging and language came from students talking science after the bell, outside of class. Because I interviewed and observed students only in the school setting, "outside of class" means that students told me of experiences and conversations that had taken place at home, on the bus, or at the park. I did not witness conversations outside of school. However, I did observe and record conversations before and after class and at lunch, "after the bell."

This kind of participation increased after the first two months of the program. By December I began hearing these stories in casual conversations and in interviews often. I provided informal, out-of-class, settings for students to discuss science in my interview groups and the KBOO lunch group. Most of the interview

data that I reference in this chapter stem from vibrant conversations between a few students and me during lunch time interviews.

When students spoke about what they were learning in science class outside of class, it reflected both student empowerment and bridging. Students were participating as members of the scientific learning community, not reluctant students in a science class. This meant that science was something they took with them into their family life and to the streets with their peers. Students were constructing new roles for science learning in their lives and using science to assert themselves with family and peers.

Most students perceive their personal world and the world of school to be very different and strictly separate. When students told me they had discussed what we were learning in science class with family, or with peers, I knew we were successful in bridging the two worlds. I use the title "talking science after the bell" because the bell that marked the beginning and end of a class period was often the border between the two worlds. Until the bell rang, the students were on their own time, temporarily free of the rigid structure and roles of class time.

Some of the examples of students talking about science learning on their own time were as simple as a student approaching me as soon as they came into the classroom and saying something that related to our projects on air quality/asthma and homelessness. One afternoon Shatiqua said to me (unsolicited before the bell rung), "There was a guy who came to get our cans. I asked him why he was homeless. He said he made some bad mistakes and is ashamed of being homeless."

As the students walked into class the day their neighborhood survey was due, I heard Eshana say to Brenna and Shatiqua, "I had 112 cars past my house." Brenna suggested, "I had 57" and Shatiqua observed, "It's so *busy*."

Some students talked to peers about science learning outside of school. Zoe told me that she called her friend in Fiji who suffers from asthma to tell her about the connection between air pollution and asthma. These stories are particularly significant because the fact that students were discussing what they were learning in science class with family, friends, neighbors, and people on the street means that some students were using their newly gained understandings from science class as social capital in their worlds. In other words, their science learning had relevance outside of school, outside of the reward and punishment system of grades and detentions.

Charlotte explained that she would never talk to her family about stuff she read in a book about the earth's atmosphere; "That's a boring conversation and nobody wants to hear about it" (I9). Latoya agreed and added, "When I talked to my family about science I talked about going to Dignity Village and seeing how people…" (I9). First hand experience and "going out on the street wise" (see discussion on students' views on school and science later in this chapter) were good material for conversations after the bell.

My favorite story of how a CMS student used their scientific knowledge outside of school came from a gregarious lanky student named Jim.

Shamu: "You ever talked about what we learned in class with family, friends?"

Jim: "I talked to someone who wasn't related to me, she had asthma and I was talking like all the lichen and...."

Shamu: "At school?"

Jim: "No, it was outside, not during school. 'Cause I just saw her, her inhaler fell and I was like 'You dropped your inhaler.' And I was like 'I didn't know you had asthma.' And she was like 'Yeah.' I was like, 'Did you know that the more lichen that's in your neighborhood the better air pollution you have and the less you'll have to use that inhaler...I was like 'It depends on how much cars and stuff.'" (I8)

Sheldon offered this story in a group interview: "Some of my friends they underage drivers. They like to get in their car and burn rubber. But sometimes I tell 'em not to do it because that cause a lot of air pollution, but sometimes I encourage it because you know you got to be at a party sometimes you gotta show off" (I7). Sheldon's honesty offers insights into the students' social world. The fact that Sheldon said (in front of three other boys in the lunch interview) that he would challenge his friends' behavior because of air pollution could be proof that science learning carries relevance in his world.

The most poignant story about taking science learning outside of class centers on one student's struggle to gain respect in public. Two weeks after the interview in which we discussed City Hall, "word racism" and the difference between "my bus stinks" and "diesel particulates," we had this exchange:

Terry: "Diesel particulates. I hate that word, don't nobody know what diesel particulates are. Remember me, you and Matt [He looks at Sheldon across the table.] Alright, we was on the back of the bus and I was like 'This bus smells like diesel particulates.'"

Shamu: "Really, did you say that?"

Sheldon: "He did. He said it to the bus driver."

Terry: "I said this bus smell like diesel particulates. And everybody just got silent and they didn't say *one thing*."

Sheldon: "And then he felt stupid."

Terry: "I was like 'Aww.' They didn't say nothing. It was like they was belittling my word 'cause I was a kid."

Shamu: "Who?"

Terry (speaking loud, with emotion): "The grown people."

Terry: "Don't people like myself deserve respect."

Shamu: "You didn't feel like you were getting any respect?"

Terry: "No, they didn't say nothing, they just kept on rollin'."

Shamu: "What were you hoping they would say?"

Terry: "I was hoping they would say 'aw really.' [He laughed.] I was hoping that other people was going to agree with me, like people sitting next to me and stuff, I was hoping they would be like 'yeah this bus does smell like diesel particulates.' Maybe they didn't know what diesel particulates was 'cause they didn't say nothing, so I feel like we the only people that know what diesel particulates are. I should have been like this bus stink and they would have been like 'yeah this bus do stink'" (I7).

Retyping this dialogue now, almost a year later, I feel both amazement that Terry did this and sadness that I misled Terry and the rest of the students about the power of scientific language. In class and in interviews, we spoke about being able to choose between using "the bus stinks" and scientific terms like "diesel particulates" to describe things the students observed. Mark and I spoke about

scientific language we could use at City Hall to convince officials to help improve conditions in their communities.

Terry believed us. Despite his mixed feelings about the scientific language ("it sounds dumb," he told me), he took the risk. He got burned. None of the adults on the bus paid any attention to the kid talking about diesel particulates. On the other hand, the fact that Terry spoke science shows both Terry's personal chutzpah, and the potential of this kind of learning to empower students, even if the world is not ready for them yet.

The conversation with Terry, Ron, Seth, and Sheldon ended on a positive note. After talking about the different context for scientific language (getting a job, City Hall, the bus), Terry and Ron talked about how "diesel particulates" could be shortened up and advertised. Terry said, "Advertise DP" Ron added, "Like Geico and all that." Terry had the last word before the bell rang, "This bus smells like diesel particulates and it doesn't save anybody any money" (I7). All of us laughed. I hope that Terry keeps speaking out to the world and that next time they listen, or he just keeps talking even if they do not.

Additional Findings on Participation: Mark's Views

This study was not designed to measure the effect of our curriculum on student participation. However, Mark's perspective on the impact of the project played a significant role in maintaining the momentum of our collaboration, and serves as an introduction to issues such as how students viewed our curriculum.

For Mark one of the goals of our collaboration was "getting the students riled up." One of the things this meant was having more students participate actively in class discussions. Mark told me he was confident that this is something our project achieved. When I asked Mark in an early November interview whether student participation had changed, he answered confidently, "We have a higher participation rate." When I asked Mark the same question in March, he thought we maintained the high level of participation we had achieved with the students.

Mark characterized three groups of students who became more engaged in science learning during this project: socially marginal students, "highly skilled students who do nothing," and "low-skill" students. Within each of these categories, Mark pointed out three-to-five students who, we both agreed, participated more fully in class during the community environmental health project. Mark frequently referred to Tobi as a great surprise success of our work. A student Mark referred to as "low," Tobi was actively engaged and completed homework for community environmental health. This seemed to jump-start his motivation for science class as a whole. A month or so into our project, Tobi started to complete assignments in all parts of science class as best he could (he could read and write only with great trouble). Tobi joined the KBOO radio lunch group, conducted interviews of teachers and students, and helped to create a rap the students recorded. He did well on weather and geology tests and continued to "nail it," as Mark said, for the rest of the year.

The students Mark described as "highly skilled students who do nothing" (Ron and Terry were part of this group) and several "low-skill" students (Gal, Andri and Tobi for instance) were failing science class. Most of them did little, if any, homework and some did poorly on written work in class. From the positive comments about the community environmental health project and their critique of school, Ron, Terry and others made it clear to me that many students chose to do assignments such as the neighborhood survey and participate positively in the presentations to younger students because they found these activities interesting or "fun."

One example of "low" students becoming engaged in the community environmental project was Mark's 7th-period class. Mark complained much about his 7th-period class. Most of the students in this class were failing and there was a lot of "off the wall" behavior. After several lively discussions with seventh period about community, environment and race, Mark began to praise the class. "Yesterday we had a great discussion. We will probably have a good discussion today but you have to do your work. I may have three people in here who are passing." To my surprise, one day Mark praised his 7th-period class to his favorite (and higher achieving) 6th-period class. Mark's perceptions of student participation affected how he saw and spoke about the students.

Research Question 2a: Bridging the Two Forms of Knowledge

Before describing ways in which students were able to bridge personal/cultural knowledge and scientific knowledge within our collaborative curriculum, I discuss how I recognized personal/cultural knowledge in the data.

Recognizing Personal/Cultural Knowledge

I identified four characteristics that were associated with students' expressions of personal and cultural knowledge. One or more of the following themes were common to the expressions of student knowledge that I analyzed in the data: (a) students used vernacular language (not formal school language), (b) students told narratives that involved either the student or the student's friend or family member, (c) students placed the experience within a setting (i.e., their neighborhood), (d) students expressed emotions such as compassion, sadness, shame, pride, and outrage.

Early in the curriculum, we asked students how we could learn about issues in their community that related to science. Latoya offered, "You can shake it out yourself, going out on the street." The fact that Latoya used vernacular, the language she uses outside of school or with her peers, indicated to me that she was accessing personal/cultural knowledge. Latoya's comments are also a good example of bridging. The teacher asked the students to think of "different methods for learning about homelessness." Latoya translated the teacher's scientific or

school language into her own words: "You can shake it out yourself, going out on the street."

In a conversation about different aspects of community such as geography and race, Isaiah offered a story about his experience in his neighborhood, "I don't want to be racist but *white* people came and took over our neighborhood." In discussions about air and water pollution and brownfields (contaminated abandoned industrial sites), several students talked about particular places in their neighborhoods.

While students were developing and choosing specific questions they wanted to ask on homelessness, one of the students, John, raised his hand and said, "I know the answers to these questions. I have been homeless." Although the class was not asked to answer these questions or turn in their work, John, a special education student who spent part of the year in our science class, wrote answers to several of the other students' questions on homelessness and turned it into the teacher. This was one of the only times during the study when I observed a student voluntarily doing extra writing work. It was one of the only written assignments that John turned in during his month in our science class.

Clearly, John's answers were from personal experience:

> How does it feel to be homeless? It feels really crappy because you don't know what to do or where to go, or what to spend your money on. Especially if you're an addict. What decisions did they make to become homeless? They could of lost their jobs and had no money and didn't know where to go. So they turned to the streets. (see Appendix E)

When students tell personal narratives and set questions or comments in a place that they know, they are using personal knowledge in science class. In John's case, the opportunity to share his experience was clearly a motivation to participate in class.

Many students asked questions about homelessness that reflected a concern about their own futures. Jim's question was very similar to questions another four or five students in his class asked, "What average bad decisions lead them to become homeless?" On the face of it, this question is not necessarily connected to the students' personal concerns. However, when I asked students why they were interested in "wrong choices" or "bad decisions" that homeless people made, several students offered answers like Kent's, "I don't want to make bad choices." The students made a connection between what they assumed were the actions of homeless people and their own lives. It is also significant that the student quoted above used the scientific term "average" as part of her question. The student could be using "average" to express the very scientific goal of looking for patterns and commonalities.

Many students expressed compassion for the homeless and for victims of asthma and cancer. Jen said about the homeless to another student, "I feel bad for them out on the street when it's cold." Talking about an African American boy in a very polluted neighborhood who died of cancer at age six, Ken said, "That's sad."

In the interview questions they wrote to ask homeless people, the students' compassion was clear:

"How does it feel to be homeless?"

"Do people make comments? Do they bother you?"

"Do you have family to turn to for help?"

"Have you ever experienced discrimination for being homeless?"

"When you are looking for a job, do you get mistreated?"

I consider these expressions of compassion as part of students' personal/cultural knowledge because of the very personal nature of the emotions. Because the majority of the students belong to racial and/or economic minorities, the questions may stem from personal experience and cultural knowledge of racial discrimination.

Students Bridging Forms of Knowledge

This study was designed to describe if and how students were able to make connections between their personal/cultural knowledge and scientific knowledge in the collaborative curriculum we enacted. We found that most students were able to bridge these two forms of knowledge. I offer some examples of these findings here, and point out that data on bridging is imbedded within findings on student-initiated participation, talking science after the bell, and language as well.

There were moments when students expressed something, usually verbally and less often in writing, that brought their personal world into the classroom, or brought the scientific world into their personal lives. Once I learned to recognize expressions of personal and cultural knowledge, it was much easier for me to identify times when students bridged to scientific knowledge. Because I knew what

we were studying in the class, I could quickly identify the scientific ideas in the students' comments. I recognized bridging in the classroom by paying attention to instances when students brought newly learned science together with personal or cultural knowledge.

I have discussed how students understand school to be almost entirely separate from their lives outside of school. In my time at CMS, particularly during the pilot study, it was very rare to hear students speaking about science in the context of their lives outside of school. This juxtaposition made the bridging stand out. The differences between scientific terms and the students' language underlined the juxtaposition.

In the community environmental health project, many students made connections between their knowledge of their neighborhood and issues of pollution and environmental justice. Often students' comments that reflected bridging were expressed in informal conversations rather than in what they said when they raised their hand to speak in class.

After the Lewis and Clark professor made a presentation about asthma rates and pollutants in Northeast Portland, I asked Zoe, a shy student from Fiji, what she thought. "What the doctor was saying about asthma it was interesting... My friend has asthma, maybe I can cure her. I can help her."

Jonah is an African American student who was absent half the school year. I seldom saw him show interest in what we were doing. At the end of class, totally unsolicited, Jonah turned to me and asked, "What's your name? Does Florida got

air pollution?" I answered, "Parts of Florida might." Jonah was clearly disappointed and shook his head back and forth heavily saying "Aww." I asked, "Why?" Jonah replied. "My Grandma lives down there."

After a group of students gave a brief presentation on an article they read about brownfields (abandoned, polluted industrial sites) in Northeast Portland, Seth asked Mark a question, "You know that place, by MLK, that field with the bricks and old fence and stuff. Is that a brownfield?" Seth was bridging from his knowledge of his neighborhood to the newly learned scientific term we just covered in class. The act of renaming a place in his world brownfield shows that scientific knowledge can fit in his world.

The section on students talking about science learning after the bell has several examples of bridging. When Jim started up a conversation with a female student at the bus stop, he used her inhaler as a conversational bridge to the use of lichen as an indicator of air quality. When Terry spoke out on the bus about diesel particulates he was applying new scientific knowledge to the familiar context of being on the bus with his friends and smelling diesel exhaust.

Research Question 2b: Aspects of Curriculum that Facilitated Bridging

"The way to get them [students] excited is if it related to their favorite thing," Seth said.

By examining data on participation, bridging, and student views on science and learning, we were able to identify aspects of the curriculum that facilitated the

connections students were able to make between home and science learning. There are five elements central to the collaborative curriculum that helped students to bridge between scientific knowledge and personal/cultural knowledge: responsiveness and flexibility, putting local neighborhood issues at the center, giving students control over parts of the learning, talking justice, and providing public, creative outlets for students to express personal/cultural knowledge and scientific knowledge.

I can offer one example of our curriculum that reflects four of the aspects. In the first few weeks of the curriculum, Mark and I wanted to get the students thinking about issues in their community. In generating ideas with the students, we used the words "community" and "neighborhood" to define the scope of the project. We found that many students did not respond to questions and ideas about their neighborhood and community. A typical response was Jen's, "We ain't got no issues" and "I don't know."

Mark and I were surprised that most students did not know the names of major cross streets, rivers, and other aspects of local geography that we thought of as important for the project. We were clearly not using the same language as the students and we had trouble knowing where or how to start generating interest in the project. A session of Internet research did not help. Even with our help finding information on Northeast Portland, students lost interest quickly.

Mark and I met and discussed the problems we were having to help the students to think about and explore their communities. We realized we needed to

start with a geographic scale that the students understood, and a hands-on activity. Based on Jennifer's comment on her community – "I am three blocks from Albertson's" – we started our observations and surveys by drawing a circle three blocks around each student's home. Students designed interview questions and observational protocol (counting how many trees were on their block, looking for sings of pollution) to learn about issues in their three-block neighborhood (see Appendix E). As I discussed earlier, this assignment was successful in generating much interest and excitement in the community environmental health project.

The creation of this first assignment was characterized by responding to students' needs, focusing on the neighborhood, giving students control in shaping the assignment, and offering a public component.

Responding to everyday teaching and learning challenges, like the one we had generating interest in the beginning of the project, was central to the action research design of this study. If Mark and I had been tied to a ready-made curriculum, or did not engage in the continual process of reflection, analysis and replanning, we could not have successfully engaged the students.

By using students' geographical scale of three blocks we were able to invite their personal and cultural knowledge and generate interest. By writing the assignment together with the students, we helped to ensure they would understand it and be interested in completing it. The students wanted to interview their neighbors and were excited about the prospect of speaking with adults outside of school. This was one of our first steps in empowering the students as scientists and

as learners, in giving them ownership over the project. In his work on effective adaptation of curricular changes, O'Donoghue (1991) recommends that curricula must be remade to be relevant for local needs. Our responsiveness and focus on the student's sense of scale are examples of this local adaptation.

Another way that we kept neighborhood and student interests central was by incorporating relevant readings and videos. We read and discussed a local newspaper article on the school building that preceded the building they were in presently. Many of the students' parents or cousins had attended the old, heavily contaminated school building.

After a discussion on the old school building and the slow response by the school district to health risks there, Mark excitedly told me, "It is starting to happen. They [students] are getting riled up...John was like [Mark acted out the students' outrage] 'If they knew what was happening why didn't they *do* something about it.'" Iyola wrote in her assignment, "Man, they should have tried to find out why all these people were getting sick." Iyola's use of "man" to start the sentence is African American vernacular and an emphatic expression of her shock or outrage. Students began to make connections between environmental issues (toxic mold, air pollution) and issues of justice. We gave them contexts to express themselves in writing and in class discussions.

We also showed a film on environmental health issues that was made by middle school students in San Francisco. Both the film made by middle school students and the article on the old school building exposed the students to examples

of environmental justice issues to which they could relate as youth, as African Americans, Latinos and Asian Americans, and as residents of their neighborhoods. The curriculum was political in the sense that we had conversations in class on issues of race, socioeconomic class, and power. We touched briefly on the political process.

We involved the politics of the classroom by asking students to vote on what issues to study, and to help design their own assignments. We tried to enact what Barton (2001) calls "participatory pedagogy" (p. 913). This is a pedagogy that, rather than relying on the teacher's authority in all matters, involves the students in choosing what to learn about and how to learn. According to Fusco (2001), adolescents have a need to participate in decision-making activities. These aspects of the community environmental project were an attempt to shift the classroom dynamics toward a more democratic approach. Mark and I were offering the students opportunities to participate in decision making in the classroom. Freire (1995) insists that we democratize content and pedagogy through a partnership of teacher and students.

Students were drawn to issues of justice and fairness, and some spoke openly and energetically about race. A class discussion about community shifted into topics of race and power in the students' neighborhoods. This discussion involved more self-initiated students' comments than any other conversation I observed. Mark spoke of this discussion as an example of "getting the students riled up." Terry told the story of white flight from his apartment building, now all

black and Mexican. Other students asked questions about why "this block is white, this block is Mexican, and this block is black."

Students expressed concern about the injustices of homelessness. Iyola said, "Nobody will give them a job and that's real scandalous. That's not right for nobody to be living on the streets." Other students asked if the government would help them.

Students were outraged about school district and city officials' negligence in dealing with toxic mold and radon risks in the old school building. Iyola spoke with passion, "So I was like 'man this radon is really messing a lot of people up' and they can't go back and give stuff back to the people....[in mock serious adult voice] 'Oh, I'm sorry there was radon in the basement'" (I9).

Talking about what he learned in the community environmental health project, Ron said, "I didn't know there was that much pollution... I didn't know there could be so much in one community and then could be so low in another. Like I thought pollution would be all over the world, but they say in white neighborhoods they get the good buses, and around here, they get messed-up buses" (I8).

The ways in which students defined themselves as scientists had to do with helping people and pursuing justice for their community. In his February science autobiography, Marty wrote about the health effects of air pollution, "I didn't really care about science but now I know what it is and I need to help keep the community clean." Adrianna explained, "I think science really means like to help

each other out, to solve problems and like giving more shelter to the homeless, letting them get a chance of finding a job and every day you find new stuff about science. It's not just about animals and stuff, it's more like about our community." Students expressed what Fusco (2001) called a human science, one deeply embedded in social systems.

Mark's goal of "getting the students riled up" involved both engagement in class and the political system. Mark explained, "I would love to see the kids get riled up about something, enough to motivate them to want to push through and learn more about it or do something about it, so they want to learn about what the problem is and maybe even how to start affecting change." This was Mark's role as a citizen of the small nation.

I use the term "political" to describe issues of power in the classroom, as well as power in the larger society. Exposing students to environmental justice issues, soliciting their comments on the role of science and discussing issues of race and power made the curriculum political. Although students did not get engaged in the legislative process, or protest local factories, I consider the exploration of differences in power to count as political.

Another aspect of empowering students was giving them contexts in which to speak publicly about their learning. Many students said that interviewing neighbors was their favorite activity, and they jumped at opportunities to speak in front of adults.

Terry, one of the many male students Mark described as "high ability but failing," said of interviewing neighbors, "I liked it because I was on the street and went up to this guy. He was like 'what?!' and then he gave me the answer. We got some nice people in our neighborhood" (I7). Ron added, "It was tight. It was fun how I got to interview people" (I7). Speaking to neighbors and family members was a way for students to gain respect and construct new roles for themselves.

Charlotte talked about "meeting people" and telling her mom that she got published in the paper. Many students were excited about having their articles, poems, and drawings published in Street Roots, the bimonthly paper of Portland's homeless community, and producing a brief radio show for KBOO community radio. Talking to people in the neighborhood was closely tied to the issues of validity that I discussed previously. Learning from "real people" validated students' personal/cultural beliefs.

Presentations students made to second and sixth graders were significant events in our project. Mark and I helped the eighth graders plan their presentation. Most students prepared notes, neighborhood maps, and other handouts. During our practice presentation sessions the students seemed unprepared. They were unsure of what they wanted to say and bickered about who should talk and when. However, during the actual presentations to younger students, most were confident, knowledgeable, clear, cooperative, and thorough.

The presentations to younger students also seemed to tap into the students' personal experience as older brothers and sisters. Many of them told me they were

not worried about the presentation because they had a little brother and knew how to act with little kids. Even some of the students, such as Tobi, who struggled with staying focused in class, were thoroughly engaged while teaching the sixth graders. Some students spoke about their success teaching the second, sixth, and seventh graders. In a rare expression of pride, Jim bragged about teaching, "It feels like you are top notch."

The popularity and success of the public parts of the curriculum were linked with issues of respect. The students wanted to be seen as knowledgeable and responsible people who deserve respect. They knew they had society's perception to overcome in order to gain respect. Several students made comments about adults not listening to young people. Students often spoke of the bad reputation of their school. On one occasion Paolo suggested that they not tell anyone they spoke to outside of the school that they were from CMS.

Freire (1998) writes that we are "conditioned" by our historical and social context but not "determined" by it (p. 26). In other words, in expressing agency, we place ourselves in our social and historical context and choose to change it. In the case of CMS eighth graders, the historic context pegged them as poor students, as ignorant of science, as irresponsible community members. When they taught sixth graders, spoke to neighbors about community issues, and wrote articles for the newspaper, the students were engaged in changing their historical context.

The KBOO radio group I facilitated as an optional lunchtime activity also built on students' interest in public presentations and gaining respect. Paolo was a

sharp, cynical Latino student who participated in the radio group. One day I thanked him for coming and being a leader in the group. Paolo smiled and said, "Yeah, you knew I was gonna be a leader." With the help of the teenage KBOO reporter who lead the radio group, even some of the students who seldom spoke out in class were drawn into conducting interviews with school staff and students.

The students in the KBOO radio group had been talking for weeks about recording a rap on air pollution and asthma. In our final KBOO recording session at CMS the KBOO volunteer and I coaxed them into finally performing and recording their rap. Isaiah, Andri, and Tobi "lay down beats" by banging on lockers in the hallway while Terry and Andri sang and rapped about clean and dirty air in the neighborhood. It was a powerful moment of public, creative expression tied to science learning.

Boykin and Ellison (1995) characterized one of nine Afrocultural expressions as "expressive individualism" (p. 99). Students jumped at opportunities to give an audience their own take on what we were learning in class. The cultural significance of unique, creative self-expression speaks to students' excitement over presentations, poetry, radio interviews, and rapping.

Mark spoke of the last weeks of presentations, the KBOO radio show, and students getting published in Street Roots, "It's been fun the last couple of weeks. We have the fruit, reap the fruits of our work. The paper [Street Roots] came out today, and it's cool to come back from lunch and hear the kinds rapping about stuff."

During my last day at CMS we had a celebration. Students read their articles and poems that had been published in Street Roots. We listened to the KBOO radio program students created. We ate and chatted. Some students beamed, some giggled nervously, others shot sly smiles at their friends across the room. The feeling of accomplishment and pride was palpable.

Research Question 3: Student Empowerment

Student empowerment means students creating new and powerful roles for themselves in classroom and in community. By powerful I mean that these roles describe students taking initiative, challenging injustice, portraying themselves as experts or activists. Empowerment is a reflection of the students gaining confidence as and community members and science learners.

Based on the data I collected, I can conclude that the community environmental health curriculum helped to empower many students as science learners and community members. My evidence comes from listening to what the students said in the context of CMS. Because in my almost two years with eighth graders at CMS I witnessed so few signs of students asserting themselves as leaders, I attach a high value to these instances that are captured in the data.

The data on empowerment emerges from various contexts: science autobiographies, student-initiated participation, talking science after the bell, issues of translation and "word racism," writing for Street Roots, and the KBOO radio lunch group. Because these findings are discussed in other sections of this chapter, here I offer a few examples and reference instances that are covered elsewhere.

Students wrote science autobiographies in September and February. The assignment was to "write about science in your life." In September the personal connections to science expressed in the assignments were as follows: looking out the window at the weather and deciding whether to wear a coat to school, and using technology such as computers and stereos. Many students described and drew "mad scientists," sometimes themselves, mixing chemicals.

In the February science autobiography more than one third of the students made personal connections, and many expressed a politicized vision of a scientist. Charlotte wrote, "Hi, I live in NE Portland and attend CMS also in Nest. My school is surrounded by companies and factories. On the way to school I see lots of trees and one thing I learned in science class was you can tell how polluted or clean the air is around you by the lichen." Joel wrote, "If I were a scientist I would try to stop pollution. Pollution is unsafe to kids and adults. Personally I hate it because I have asthma."

In his February science autobiography, Marty wrote about the health effects of air pollution, "I didn't really care about science but now I know what it is and I need to help keep the community clean." Adrianna wrote, "I think science really means like to help each other out, to solve problems and like giving more shelter to the homeless, letting them get a chance of finding a job and every day you find new stuff about science. It's not just about animals and stuff, it's more like about our community."

After almost 6 months of the collaborative curriculum, many students were expressing a new conception of a scientist as someone involved in social change and service to the community. These comments are very different from the "mad scientists" depicted in many September science autobiographies. The "mad scientist" is often described by students as mixing chemicals and causing explosions. There is no connection to specific scientific concepts, or community identity and needs. In writing about scientists as "trying to stop pollution," not only were students identifying as potential scientists, but they were imagining themselves as using scientific knowledge for the good of the community. Students were gaining a sense of themselves as change agents in the world.

When Terry called out on a public bus, "This bus smells like diesel particulates," he was confronting stereotypes about African American males, and young people in general, and expressing himself as a concerned, scientifically-literate citizen. Empowerment is students confronting injustices in school and community, as well as accessing and experimenting with the role of knowledge in social change.

The KBOO radio lunch group was an important vehicle for students to create new roles for themselves. For example Tobi, the class clown with failing grades, recast his identity through his participation. Tobi attended all the meetings, helped to craft interview questions, learned to use the recording equipment, and conducted interviews of CMS students and teachers. Though I was never able to confirm this with Tobi, Mark and I thought that his participation in the KBOO

group helped him to engage in science class. As the curriculum and the KBOO group progressed, Tobi began to do his homework, pass his tests, and participate constructively in class. Andrianna, a socially marginalized student whom I observed socializing almost exclusively with adults and her friend Gal, became an integral part of the six to eight students in the KBOO group. In our last meeting, she helped to record a rap with Terry, Isaiah, and Tobi. Outside of the KBOO group, Paolo was a successful but deeply cynical student who seldom spoke out in class. I thanked Paolo for coming and being a leader in the group. He smiled and said, "Yeah, you *knew* I was gonna be a leader."

Toward the end of the study, Mark called me on the phone to tell me that several students, Marty and Andrianna included, asked if they could do a water quality study at the school. They had observed that the tap water in Mark's classroom tasted different than in other classrooms and were concerned about lead and other pollutants. Mark's voice expressed excitement in the students' ability to take initiative in the context of science and their school.

Wenger (1998) looks at learning as a "vehicle for development and transformation of identities" (p. 13). He sees participation as linked to identity building. One of the reasons our collaborative project was able to raise participation and empower students was because students used the activities (recording for radio, writing articles, presenting to younger students) and knowledge (diesel particulates, asthma, lichen and air quality) as vehicles to transform their identities. Students participated in science and in the school and larger community in new ways. This

project, particularly the public aspects of writing for Street Roots, recording for KBOO, and doing presentations, offered opportunities for the students to build new powerful identities: community scientist/activist, rapper, poet, radio reporter, and teacher.

Three Stories: Tensions, Bridging and Empowerment

Taking a step back and looking at my findings, I see that my research interests of participation, different forms of knowledge, and empowerment were embedded in larger questions of how the students and teachers perceived and treated each other. I searched for a central metaphor, a story, to encompass what I saw and heard at CMS beyond the scope of my research questions. I chose metaphors of nation, empire, and bridges because they carry implications of culture and identity, power and struggle, boundary-crossing and collaboration. These stories offer useful frames for understanding the ways the equity gap gets acted out in the classroom.

The themes of this dissertation form three interconnected stories. They tell a story of tensions between what I call the "empire of school" and the "small student nation." They tell a story of the collaborative curriculum as an attempt to build a bridge between these two worlds. They also tell a story of students becoming empowered, finding new ways of being science students, and adopting new roles in their community.

The empire represents mainstream society: white, middle class, adults, city hall. The small student nation represents poor people, young people, and minorities

such as Latinos and African Americans. With the teacher as its primary representative, the powerful empire offers the rewards of good grades that stand for the future reward of wealth and the social and legal protections it affords. The empire demands the students' loyalty: sit and listen, do homework, and adopt the knowledge and language of the empire.

The small student nation gives the students identity, community, knowledge and a set of beliefs and practices that often conflicts with the school world. The students have a language, ways of learning, and their own epistemology, or what counts in their world as knowledge. The nation has little if any economic or legal power but holds the loyalty of many students.

The empire of school considers the students' world a threat and punishes students' for practicing their beliefs. The nation of students finds ways of resisting the school and asserting their beliefs and practices. The teacher demands that students become loyal citizens of the empire. The students demand to be recognized as a sovereign nation whose autonomous citizens can choose their paths. They are locked in a pattern of imposition and resistance. There is very little border crossing between the empire and the student nation. However, the teacher's loyalties are divided as he is part of the African American community. The students at times share some of the empire's beliefs.

The collaborative curriculum represents the materials for building bridges between the two worlds. The goal of bridging these two worlds is science learning, mutual respect, and the sharing of economic and political power that are more

available to students who succeed in school. The building of bridges equips students with new knowledge and tools to assert themselves in the small student nation and the empire of school.

The story of students gaining a sense of agency is about what it means to these eighth graders to learn science that is relevant to the small nation. Student empowerment is about how the students' view of themselves as science learners, students, and community members changes during the study. The tensions between the empire of school and the small student nation and the possibilities of bridging are reflected especially in the findings that extend beyond the scope of my research questions: teacher's and students' views on school, science, and pedagogy, language, and what students learned.

The Teacher's View on Pedagogy and Science

"I get frustrated with the choices I need to make...I end up doing things out of convenience, a lot of things, so it doesn't end up being authentic" Mark.

During the pilot study and dissertation study, a recurrent pattern was Mark's struggle to balance what he wanted to happen in the classroom and what actually happened much of the time. He talked about "authentic" or ideal pedagogy and the pedagogy of "convenience." His ideal pedagogy was "student-led" and "constructivist." He interpreted this as working in groups, creating a safe space for students to be curious and ask questions, and having time to get to know his students as individuals. At the end of the pilot study Mark did an activity where students wrote as many questions that started with "I wonder" as they could. "You

should have been there," Mark excitedly described the activity and students' questions and ideas. This was Mark's ideal.

However, because of time pressure, student behavior, and other factors that related to the situation at CMS, Mark compromised his teaching ideals for the sake of convenience. Convenient pedagogy involves more textbook work, worksheets, teacher-talk, and fill-in-the-blank tests. In other words, convenient pedagogy is what Mark said he ended up doing because he felt too squeezed by preparation time and class time pressures, by expectations of covering content, and by student behavior. This fall Mark discussed the dilemma, "Which again, ideally a lot of that is better teaching, to be more student-led and constructivist in it, but it's difficult to get there."

Mark argued that one of the obstacles for him in teaching his best was the school itself. The students and other teachers, he commented, were negatively affected by the school administration's decisions and the atmosphere they cultivated. Mark also felt he had to make up for other teachers' shortcomings. He felt mistreated by the principal (removed from role of committee chair without being consulted), embattled by new rules on field trips and classroom visitors (like the scientists and activists we invited), and infuriated by the disruptive shuffling of classes, teaching assignments, and schedules.

Dozens of times our planning meetings were disrupted by the last-minute staff meetings and schedule changes. Many "prep" periods were spent commiserating and discussing political tactics with other teachers. Speaking to a

teacher down the hall about the school climate and its effects on the students, Mark remarked, "The adults are pissed off and the students can sense it. They are off the wall." From Mark's view the school atmosphere made it harder for him to enact "ideal" pedagogy.

On days when I observed Mark lecturing, he would invariably apologize, "I am talking too much. It takes a lot of direct instruction to do this." On another occasion Mark spoke of not doing enough group work with the students, "I did a workshop on it. I should be doing it this year. There are a lot of things I should be doing this year that I am not." Kincheloe and McLaren (1998) argue that the goal of research aligned critical theory is the "self-conscious criticism" (p. 265) that Mark expressed about his teaching. This is one of the ways that our research was *for* practice rather than *on* practice (Bouillion & Gomez, 2001).

Because the kinds of activities I planned for our collaboration were student-centered and based on a social constructivist perspective on learning, perhaps Mark felt embarrassed when he was not doing the "right" thing in the classroom. However, considering his genuine excitement over student-centered activities, such as "I wonder," students rapping on air pollution and asthma, and the poetry that students wrote on the topic of homelessness, I think the student-centered approach spoke to Mark's identity as a teacher.

P. J. Palmer (1998) insists that we pay attention to how our identity gets expressed through teaching. He writes that teachers do the best teaching when they "teach from an integral and undivided self" (p. 14). Personal unresolved

contradictions in our lives get expressed through teaching and our students suffer for the lack of heart and wholeness. Mark struggled with the division between his identity as an African American teacher deeply concerned with justice and environmental issues, and his identity as a science teacher that demanded that he cover mandated content and control student behavior.

In this study, the demands of collaboratively planning a curriculum that elicited student knowledge about their communities, gave students choices, and led to action on community environmental issues once again led Mark to reflect on his teaching approach. I noticed a new element emerge in the discussion around two kinds of scientific knowledge and their relative value in the classroom. Table 4 describes, from Mark's perspective, the two sciences and their characteristics. All of the data in the table comes from interviews, observation, and conversations with Mark. All statements that appear in quotes are Mark's words. Text not in quotes is based on my analysis of interview and observational data.

Mark saw the collaborative curriculum that engaged students in investigation of and action on community issues as wholly in the "Community-Based" column. Mark was enthusiastic and, to use his words, "riled up" about the community-based work. It clearly connected to his personal values, his identity as an African American environmentalist, and his sense of place as a resident of the same Northeast neighborhoods where his students lived.

Table 4

The Two Sciences According to Mark

	"Hard Science"	**Community-based Science**
Epistemology	Right answer Accurate	"No right answer" "It's really an emotional science"
Learning Goals	"Content," Filling "holes" in student knowledge Content Goals: Geology, Climate, Astronomy	Awareness Development of sense of surroundings "To get riled up" To be a citizen activist Scientific skills Asking questions
Kind of Pedagogy	Convenient Pedagogy District curriculum Teacher talking Textbook Worksheet Demonstration labs	"Authentic" Pedagogy "Student-centered" "Student-led" Discussion Constructivist Project-based Group work
Amount of Work for Teacher	"More efficient"	"Wearing on me" "More difficult" Takes a lot of time
The Nature of Planning and Teaching	Certainty in planning	Uncertain what's next "You lose control, you lose product"

Mark was excited about the higher levels of student engagement, particularly among "highly skilled boys who do nothing," and personally interested in learning more about the community issues. The pedagogy associated with community-based science aligned with Mark's view of "authentic" pedagogy. However, as the school year progressed, Mark felt more and more stressed about the amount of time, planning and class time that our project took away from the hard science curriculum.

In line with what Mark characterized as the pedagogy shaped by convenience, hard science was more efficient and easier to do for the teacher than community-based science. The teaching methods, though not ideal, took less time for the teacher to prepare and deliver. "Convenient pedagogy" reflects what Freire

(1995) characterized as adapting to the world rather than changing it. The opposite of empowerment, "convenient pedagogy" is one of the ways that Mark adapted to what he considered to be difficult teaching conditions.

Mark described hard science as the school district mandated units on climate, geology, and astronomy, as well as events such as the science fair. In conversations on the pros and cons of each approach, Mark spoke of the holes in the students' knowledge, and the need to cover his mandated units. He seemed to speak of hard science with a strong sense of obligation but without much excitement. For example, in one conversation Mark first defended the importance of scientific literacy in terms of students' understanding of specific scientific concepts. However, his comments ended with a Carl Sagan quote about the importance of students discovering things for themselves, a sentiment better aligned with "community-based science."

I do not know if Mark's lack of excitement about hard science reflected what P. J. Palmer (1998) calls a "divided self" (p. 15), or rather his desire to be supportive of our project and my passion for community-based science. At times, the tension between the two sciences surfaced in the classroom.

In mid-December I observed Mark's conflict between constructivist and traditional objectivist pedagogy, hard science and community-based science, emerge around defining scientific terms with the students. He encouraged students to use their own language while writing his own words on the board. While working on the students' vernacular/scientific glossary, Mark stood at the

blackboard and asked students to offer definitions "in their own words." A student offered a definition of macro invertebrates and, in place of writing the students' words on the board, Mark wrote down a more formal definition. He then told the students, "You don't have to write exactly what I am writing." I do not think Mark was conscious of the contradictory messages he was giving the students and we never spoke about this occurance. He asked them to use their words and yet he did not use their words on the board. This pattern repeated itself on several occasions.

One of the curricular dilemmas and collaborative conflicts Mark and I had to work out involved neighborhood mapping. I suggested that students use white boards to make their own maps of Northeast Portland (we had studied city maps) by choosing important natural, cultural and personal landmarks (bodies of water, schools, parks, and stores) Here is our dialogue that served later as the prime example of the conflict between the two sciences and their pedagogies:

> Shamu: "They[students] could draw their own simplified maps on white boards."
>
> Mark: "There aren't enough of them who could get it accurate enough. It would be a good test question."

In our final interview, I brought up the mapping dilemma. Mark explained that he thought that the students' inaccurately drawn maps would be confusing for the younger students and we would "look like idiots." On the other hand, I saw students drawing their own maps and using them to teach younger students as an opportunity for constructing knowledge. When I asked Mark if he saw a benefit in the students drawing their own maps, he replied,

> There's a quote I cut out, I wish I had it right here. It's Carl Sagan..."when people discover something for themselves they remember it for their whole life." Even if it has been discovered 8 million times, if you discover it for yourself, it's a wonderful thing. If they're creating their own maps, find a way to make their own maps that *work.*

This is representative of the tension between hard science and community science, between authentic and convenience pedagogy; students' need help to draw their own maps that work. The "product" as Mark called it, is a construction of the students, and it is accurate. However, I found that in many cases this balance was also a kind of ideal that was hard to achieve. In this case, Mark decided that the risk of making mistakes was high and we did not have time to spend helping students create accurate maps. For the presentations to second, sixth, and seventh graders, the students used official city maps.

Zahorik (1997) worked with teachers helping them shift to constructivist pedagogy. He writes that one of the main challenges for teachers making this change was the tensions between expert constructions and students' constructions. Zahorik's work perfectly describes the map dilemma we had. He suggests that the way to overcome this obstacle is to not to choose the one established or accepted construction but rather to have a conversation in the classroom about the similarities and differences of the two constructions.

This suggestion parallels Delpit's (1995) recommendation to talk with students about the different contexts and uses of school language and students' language. On the subject of scientific language and student language, we were able to have the conversations Zahorik (1997) and Delpit recommend. At other times,

such as the map dilemma, we were not able to discuss these tensions and choices with the students.

Studies have been conducted describing the ways in which curricula based on science inquiry has been "diluted" in its implementation by teachers (Huberman & Middlebrooks, 2000). Science inquiry curricula, based on constructivist pedagogy, share with community-based science an emphasis on a student's questions and first-hand exploration. Studies describe the ways teachers need to be supported in order for them to examine their beliefs about content and pedagogy (Blumenfeld, Krajcik et al., 1994). This examination of beliefs is central to teachers shifting to pedagogy based around constructivist perspectives on learning (Blumenfeld, Krajcik et al., 1994; Huberman & Middlebrooks, 2000).

While our collaboration provided important support for the exploration of Mark's beliefs about teaching, time was a major obstacle. Mark felt pressed for both personal time and teaching time, and research shows that the kinds of shifts we were trying to make in the classroom take many years to realize (Krajcik et al., 1994).

It is clear that Mark's personal identity aligned his loyalty with the small student nation and the kind of science learning that centers on the students' interests and enthusiasm. However, as a representative of the empire of school, Mark often felt pulled to the science teaching norms of the empire.

Unfortunately for the learning process of the researcher, the teacher, and the students, I do not think we got past the dichotomized view of the two kinds of

science and ways of teaching. In the last weeks of our collaboration Mark wrote about the students' perception of science, "Science is what you learn in that class at school. It has nothing to do with my everyday life. I think that we made some inroads with this...unfortunately, some of our students now don't see how this project relates to any other aspects of science."

The positive results of the community health project (for example, students taking about what they learned outside of class, some students participating more in class, student awareness of neighborhood issues, etc...) did not always transfer to the science units students studied for most of the school year. In other words, according to Mark, many of the students who were actively engaged in our community environmental health project, disengaged when they were studying volcanoes or weather patterns. The students perceived the worksheets and reading on geology or climate as completely different from interviewing neighbors on community issues.

Students' Views on School and "Actually Doing Stuff"

"I think it's better than just sitting in the classroom listening. I think we should go out more and just test it out," Shatiqua said.

In both the pilot and dissertation study, the students spoke with unanimity on the difference between typical school learning and "actually doing stuff." It is clear to me that much of the success we had in the program in terms of student participation, learning, and empowerment was related to the fact that the majority of students perceived many of the activities as "going out" and "actually doing

stuff," not as the usual "sit and listen." Here the tensions between the empire and the student nation are clearly delineated and the equity gap is expressed in cultural differences.

Table 5 describes the students' views of school and "streetwise," and the characteristics of each. I used students' words (in quotation marks) wherever possible. All text in the table comes from interview and observational data. Text which is not in quotations is my summary or analysis of data.

I use the table here to offer students' views on school and pedagogy and to introduce a number of issues that I discuss later in this chapter. Students' views on the usual classroom activities and "streetwise" or community-based learning offer insight into the disconnect between home and school, student learning, participation and behavior, the importance of language and social capital, and the potential and challenges of learning that bridges home and school.

The much-researched separation between home and school contexts for minority and poor students (Barton, 1998; Delpit, 1995) is reflected here in Iyola's sarcastic comment, "Hey mom I learned about the atmosphere.' My mom may not even know half the words I'm talking about so it's not going to be very interesting" (I9). She insisted that she would use scientific language only in class. Additionally, views on what kinds of knowledge are valid speak to the home-school divide. Many students viewed comments they heard first hand from neighbors or visiting

Table 5

Students' Views on School, Science, and Learning

Students' View	"Straight out of the book"	"Streetwise"
Methods/ Pedagogy	"We just sit there and listen to the teacher talk and talk" (I1) "We just look at a book and then have a test" (I1) Worksheets "Reading and looking for answers" (I5)	"We are actually doing stuff." "Actually going out to the street wise" (I9) "First hand" (I9) "Shake it out yourself" Talking with people Talking with friends Experiments Water labs Field Trips
Validity	"What one scientist thought" (I5) "That's just what the book and scientists say" (I5) "Just hear it out of a newspaper" (I1)	Diverse Opinions "They give you real answers 'cause its real people" (I5) "You know first-hand" (I9) "Hearing the actual person talk about it" (I9)
Social Capital	Need to know for high school, college, job Boring Nothing to tell parents about No one understands it	"Get to meet people" "Mom, I got my poem published." "Get to play a little detective work" Talking Justice Talking to peers, adults
Learning	"You're just sitting there and you're looking in the book trying to remember everything you that you just learned" (I5) Abstract	"When you are not reading a book you wanna have experience with it you get visions…we can see it inside our visions and emotions and how we carry it" (I9) "You get to talk about it, you get to say how you really understand it" (I9) Personal construction
Student Behavior/ Classroom Management	"I noticed since we were studying out of a book and everything seems like everybody is getting in trouble for not doing their homework" (I9) "Bunch of people half asleep, talking" (I9) "'Cause I get sidetracked easily if its just listening" (I9)	More students did homework "They are all talking about how excited they are about the experience and they're trying to do the work" (I9)
Language	Big words Frustration "Hard to remember" (I5) Family, friends don't understand half the words Use it only in science class Trying to learn for college and job	Need to"shorten it up" "nick name it," "advertise it" (I7) "DP" for diesel particulates "Homeless, it gives all the basic factual details of it just by one word" (I9) "Dignity village, I like how it sounds" (I9)

scientists or activists as more valid than what they read in books. These were "real answers 'cause it's real people," rather than "just what the book and scientists say" (I5).

Students said they preferred to learn by first-hand experience, through talking with people, seeing things and experimenting, rather than to "sit and listen" or "just look at a book" (I1). One finding that surprised me was that students included in their list of what was "actually doing something," the kind of rote, procedurally focused activities such as water chemistry and the water cleanup lab. In my observation of these activities, I found that although students gained the skills of doing the tests, they did not understand why they were doing the tests or what their data meant.

For the water labs, unlike the activities of our collaborative curriculum, students did not choose the issue or the method, and the labs did not have public elements. However these labs did represent first-hand knowledge, and they definitely meant getting out of the books and getting out of the classroom.

One seemingly contradictory finding was that some of the girls whom I interviewed said they did not see any real difference between the activities of the community environmental health project and the usual activities of school. Two of these female students spoke about a need to participate in the "straight out of the book" learning for college, or a future job, the rewards of the empire. The majority of students I spoke with, particularly Latino and African American males such as Ron and Terry, saw no reason to "sit and listen."

These female students strongly contradicted what many other students said about "sit and listen" and "actually doing something." These girls were generally quiet, followed the rules, and did their homework. This finding fits with Boaler's (2002) work on girls' adaptation to school. These girls are playing by the rules of the empire, and in the interview I felt as if they were telling me what they thought I (a white adult authority figure) wanted to hear, not what they thought.

Though the students used different terms than Mark, much of what the students talked about as "straight out of the book" fit well under the "hard science" category in Table 4. The activities, pedagogy, learning, validity, and student behavior of "Streetwise" learning aligns closely with what Mark called "Community-based" or "Environmental Science." Students' views offer one explanation of their resistance, and Mark's frustration, with teaching "hard science." The students clearly were drawn to what Mark called "emotional science," group-based work, and to the lessons of awareness about their neighborhoods. By "emotional science," Mark meant exploring the environmental justice issues in ways that elicited students' ideas and emotional reactions of anger, compassion, or sadness.

Language

"They [teachers] just say it and we got to put it into our words," Seth says.

Within weeks of starting research, I was awed by the ubiquity and complexity of issues surrounding language. I discuss four language-centered

themes: students' perceptions of scientific or school language, students' views of reading and books, translating, and "word racism."

Students on School Language

When Seth said to me thoughtfully, "They [teachers] just say it and we got to put it into our words," he was commenting with a little bitterness on the divide between the language of the school and teachers and that of the students. Referring to signs at the nearby nature center, Anna said to me, "I don't like that they used words we didn't understand."

The one event that made the distinctions between school and student language sorely obvious was the visit to CMS by a Lewis and Clark professor who had been working on environmental health issues in Northeast Portland. At one point in the presentation, the professor asked the class, "With what frequency do you ride the light rail?" Total silence followed. Mark quickly yelled out, "How often do you ride the MAX?" and students started to raise hands and call out responses.

In a later interview with Terry, he said of the professor, "He used big words. I don't understand him." Morris said of the professor and other scientists, "They talk too slow. Language, the way they say certain stuff. Mr. Mark ain't gonna say like real scientists say. He uses big ole words and Mr. Mark, he like...chops it down." Jim interjects, "So we can understand it...just like the kid's Bible" (I8).

In a January lunch interview we discussed "this bus stinks," the language many students had used to connect air quality issues we were discussing with their

personal experience riding buses. I asked Terry if he would, on the bus, use "big words" like "diesel particulates" (a term we had introduced to the students) along with his phrase "the bus stinks." Terry laughed and replied, "It's like, if I was on the bus, I *would remember* the big word but I wouldn't say diesel particulates because that just sounds dumb. I'd say fumes or something" (I5). Even when students understood or wanted to understand scientific language, such as Terry's assertion "I *would remember* [his emphasis] the big word," it was not appropriate to use on the bus, or in other settings outside of school.

On the other hand, students agreed that scientific language would be a good choice at City Hall, rather than saying "the bus stinks." Ron commented, "You're using the smarter word." Seth added, "It's more mature" (I5). This is an example of conflict within the students' beliefs. While they often prefer their own language, they think scientific language is smart and mature in the right context. Here students are recognizing the power of the majority culture (Delpit, 1995). Mark was also conflicted in his loyalties. While he used African American vernacular with the students on occasion, and once played for students a recording of a rap on the contributions of African American scientists, he also made fun of the students' language, sometimes to the students' faces.

In preparing students to do analysis of their data from survey of tree lichens (an air quality indicator), Mark asked students what "data analysis" means. Several students offered ideas and Mark filled in their comments and provided a definition. As part of this process, Mark told a story about Shaq and Kobe, two African

American basketball stars. When asked on TV by sports commentators to offer his "analysis of the game," Shaq replied that he did not know what analysis was. Kobe understood the request and offered his analysis of the game. Mark concluded the story by saying of Shaq, "What an idiot. I hope we are not like him."

Later in the same class period students were working on their scientific/vernacular glossaries and I asked Arianna how she was doing. Arianna replied sarcastically, "I don't know what analysis is. I am like Shaq. Yolanda is like Shaq too. She don't know."

There are several themes coursing through these anecdotes. Arianna and Yolanda were two of these most silent, and seemingly unhappy, students among all the eighth graders I worked with. One theme involves Arianna's defiance of Mark, or perhaps her getting back at Mark for what she perceived as an insult in his comments about Shaq. Kohl (1994) writes that students' resistance often centered around issues of relationship with the teacher and whether the students felt like they were being treated with respect. Kohl characterizes some of these stories of student resistance as "I won't learn from you," and "I won't be stupid." I think Yolanda was saying both.

A second theme reflects the fact that given the choice that Mark offered, she chose to align herself with Shaq and his language rather than with the language of Mark, the sports commentators, and the school or authorities in general. The students' frustration with the signs at the nature center and the professor's language were clear examples of two entirely different languages and of their struggle

translating between the two. I think that Terry's rejection (at the time) of the term "diesel particulates," and Arianna's rejection of "analysis," considering that these students had translated and understood the terms, was a matter of the students' loyalty to their own language and their resistance to adopting the competing language of school. In other words, these members of the small student nation hold on to their ways when those ways are threatened by the empire of school.

It is interesting to note how Mark's identity as an African American affected issues of language in the classroom. Some students may have developed an easy rapport with Mark partially because he is African American. However, in the story of Shaq, Mark used his role as authority in the classroom to ridicule an African American basketball player because he did not understand the language being used around him.

Reading, Writing, and Books

The boys I interviewed, in addition to several others, complained about having to read and write. Common responses to reading I heard were, "I don't want to read" and "Do we have to?" In a comparison of reading and doing hands-on work, Seth explained, "You know, a book isn't really much fun 'cause like, we're reading." Terry offered, "I don't do nothing straight out of the book because I don't like reading and looking for answers" (I5). In the students' description of school versus "streetwise" (see Table 4), reading played a large role in defining the usual and boring aspects of school. Charlotte offered her observation of classroom

behavior and reading, "I noticed since we were studying out of a book…bunch of people half asleep, talking" (I9).

Students considered the language used in books as well as the way teachers used books to be boring. One student critiqued the way students were expected to use books as "reading and looking for answers." Additionally the validity of books was suspect. Students compared talking to people (surveys, guest speakers) to books, "What one scientist thought" and "That's just what the book and scientists say" (I5).

Seth compared listening to the formerly homeless activist/artist who visited the class to reading from a book, "We're just reading out of a book…We actually had like a homeless, like, come in and, you know, talk to us…We got notes and stuff from like an *experienced* person, who has actually been there. So it's better… In the book that was just science people running around asking people. It's more real." Terry explained why he liked the interviews and surveys of neighbors, "Because they give you real answers…'cause it's real people" (I5).

Iyola explained how our project was different, "I never did nothing like this in my other science classes. But now we're getting to where we actually going out to the street wise and actually seeing the air pollution…so we wanna liven it up, having more experience…I wanna have my adventure." Charlotte excitedly interrupted Iyola with an example, "Like Dignity Village, we met people and we don't just hear out of a newspaper what people think. We actually got to talk to them firsthand and they tell us how they feel" (I9).

It is clear that students considered hearing something first-hand, from a neighbor or homelessness activist, more trustworthy and valid than reading something from a book or newspaper. This belief fit well with our collaborative curriculum's emphasis on community issues, public involvement, and students' personal and cultural knowledge. Perhaps one aspect of the students' alienation from school was that they did not trust the authority of textbooks over the authority of people in their community. By empowering students to bring their personal knowledge into class we were elevating the authority of their community-based knowledge.

The only reading in science class that students got excited about was Street Roots, the biweekly publication of Portland's homeless community. They particularly enjoyed the poetry section. Within minutes after passing out the papers to students, there was a rare quiet in the room that lasted for most of the class period. Several students asked if they could keep the papers to show friends or family, or to use in assignments in other classes. Many students showed me or read to me poems they liked. Some commented on what they had read.

The poetry had rhythm and rhyme, and this together with its use of vernacular language and meaningful (to the students) themes (homelessness, love, racism, police, drugs, justice) made reading poetry different from reading a textbook. Brenna, a shy African American girl, pointed out an article to me as I walked by her desk. "I like this part," she told me referring to an editorial on the Civil Rights movement as inspiration for today's struggles for justice. "They're

powerful words," she said seriously, "I wonder who wrote it?" I asked Saul, a quiet boy what he thought of what he was reading. "I liked the poetry," he said, "it expresses feelings and stuff."

When students were reading articles on community environmental health in Northeast Portland, I was walking around the room helping students understand what they were reading. After summarizing one paragraph to a Latino student, she said, exasperated, "It make sense when you break it down like that but if I just reading it, I don't understand nothing."

To Translate or "Break it Down"

When confronted with the problem of using scientific language outside of school, many students came up with the suggestion of translating the scientific term by making it shorter. The student who needed me to "break it down" was asking me to translate from the scientific language in the article into her own language. We had the following conversation about diesel particulates and other big words.

Ron: "I think they should shorten it up, and advertise the word."

Terry: "Like DP, it smell like DP on this bus."

Ron: "Yup" (laughs).

Shamu: "Why do you want to shorten it up?"

Ron: "Cause, man, when they advertise it on the bus, make a commercial."

Terry: "Advertise DP."

Ron: "Like Geico and all that.

> Terry: "This bus smells like diesel particulates and it doesn't save anybody any money." (Ron, Terry, and Shamu laugh) (I7)

Charlotte and Iyola, two African American girls who did all their homework and got high grades, told me that the only place they would use scientific language was in science class. They continued,

> Charlotte: "He [teacher] says this is the lithosphere latta latta, but if you don't give us a visual....We don't know what it is we just know what the book says and then we go home and try to share with our parents and say 'oh, we heard the lithosphere is blatta blatta.'"
>
> Iyola interrupts: "They be like, what is that? You gotta nickname it."
>
> Charlotte: "What, the lithosphere."
>
> Iyola: "What I mean by nickname it, like lithosphere is hard to pronounce, 'oh, yeah, that's the lit.' You know break it down, make it smaller...You heard about the lit today, it's so hot" (I9).

After translating, students experimented with using scientific language in their own world, combined with their vernacular. The juxtaposition brought on lots of laughter.

"*Word Racism*"

In one of the rich interviews with four African American boys from which I have quoted often, I spoke about the different uses for scientific and students' language. I explained that we were trying to get them to learn scientific terms because if they go to City Hall and say "This is the number we got when we took a reading of diesel particulates," they will be listened to better than if they say "My bus stinks."

Terry challenged me, "I don't think that's fair," he said. "I think it's word racism. You don't use the big words and people won't listen to you but if you use the big words, people will listen to you. I think you should be able to say anything you want, phrase it in any way. People should just listen, 'cause you should just listen" (I5).

Terry in particular amazed me with his insights. I understood Terry to mean that not listening to people because of the words they are using is like not listening to them because of their race. Perhaps Terry saw the two languages as racially identified: white scientific city hall language and black language. Many scholars have pointed to the linguistic aspects of racism (Baugh, 1999; Hopson, 2003). Language helps to define participation in a particular cultural group (Delpit, 1995). The fact that certain kinds of language carry more power at City Hall was to Terry an injustice. All languages should be listened to; "People should just listen."

Learning

The goal of the study was to initiate curricular and pedagogical changes in the classroom that raised and improved student participation in the classroom, helped students to bridge, and empowered students as science learners and community members. Within these findings is embedded data on what and how students learned. This section explores some of the lessons of awareness and knowledge of science content that students expressed. I also examine the challenge we had working with district-mandated science units, and students' view of their learning process.

In one of our last interviews, Terry told me, "Most interesting thing I learned was air pollution. Until now I never really paid attention to air pollution. I mean it bothered me but I didn't know, like, about it. I didn't know what to call it." Ron offered, "I didn't know there was that much pollution....so much in one community and so low in another" (I8).

Andri talked about a new awareness of her neighborhood, "Well, I liked the 'get to know your neighborhood' because I didn't used to walk around and look at things" (I6). Several students spoke of the effects of personal choices, riding the bus or walking rather than driving. For students who studied homelessness, personal choices about education and drugs were central.

When I asked Mark in November what he thought the students had learned in our curriculum he emphasized awareness over specific science concepts. "It has helped them to learn environmental awareness, background health things," he said. "More importantly they are more aware for the rest of their lives." At the end of the project he wrote about his own experience, "I will never look at lichens the same way. I will never look at homelessness the same way either." Terry, Andri, and Mark's growing awareness of their neighborhood is a first step in empowerment. Students who spoke about transportation choices, and personal choices about education, drugs, and homelessness were expressing a sense of their agency informed by science learning.

Student presentations offered what scholars characterize as real world tasks for assessment (Smith-Maddox, 1998). I was able to observe and record what the

majority of the eighth graders in our project were teaching to their second and sixth grade students. Students described the connections between air pollution, race, and asthma, and could identify aspects of the environmental and social geography of Portland on a city map. Almost all the eighth graders could point out Northeast Portland landmarks: Columbia Blvd, CMS, Columbia River and Slough, and their own houses. They knew that the air quality was worse in these areas than in other parts of Portland and could offer some explanations: older TriMet buses, truck traffic, I-5, and industry. Paolo pointed out parts of the city on a map to his sixth graders, "It says right here the most polluted place is the darkest. This is my neighborhood. I know all the homies." Several students talked about the fact that "radon...can give you headaches and stuff" and that "lead can make you lose intelligence."

The majority of the students I observed successfully identified the three kinds of lichen and what kind of lichens are indicators of clean air. The students who studied homelessness (one class out of four) spoke and wrote about the causes of homelessness and the steps some people took in getting themselves off the street. Many students wrote about the variety of community resources available to help the homeless and to confront environmental justice issues in their communities.

Mark knew how to cover science content. He was eager to learn ways of engaging students and getting them "riled up." Both Mark and I felt that putting content objectives (e.g., "students will learn the five most common air pollutants") at the center of the study would counteract student engagement and lead us away

from the student-driven approach we thought would get students excited about science. This is where we struggled with the balance between engaging students and giving them access to scientific knowledge, an important aspect of the "majority culture" (Delpit, 1995, p. 142).

Although Mark and I had planned to align our curriculum with the Oregon benchmarks, I found that many of the 8th-grade science benchmarks were difficult to use in conjunction with our student-led process. The benchmarks designate what students should know and be able to do in science. The majority of the benchmarks were based on concepts such as "Physical and chemical properties of substances" and "Changes over the Earth's surface over time." Tobin et al. (2001) also found that "meeting district standards and the lifeworlds of African American students are not necessarily commensurable" (p. 958).

We decided not to focus on benchmarks or testing in the creation of and evaluation of our curriculum because (a) according to Mark the benchmarks are only loosely tied to the state science tests, (b) we decided that other issues such as bridging and student participation were better suited to our interests and methodology, and (c) we felt that testing involved issues such as reading and writing skills that we were not prepared to assess. Research has made the links between language and standardized test scores (Smith-Maddox, 1998). Hopson (2003) argues that the problem of the "language line" is the crux of educational inequalities.

Benchmarks that our curriculum did cover included "scientific inquiry," "science content reading skills," "cause and effect relationships," and "science in personal and social perspectives." The students frequently demonstrated their understanding of cause and effect, and personal and social perspectives on science. Scientific inquiry, as defined in the benchmarks, was harder to teach in the context of community issues. Although students developed questions that guided the investigation of community issues, those questions were not framed in a traditional scientific format, for example testing a hypothesis.

At the end of our project, one issue arose around ways scientific questions and projects are structured for the science fair. Several students asked Mark if they could do projects on asthma or homelessness or pollution. However, because science fair projects had to be something students could test in a few weeks, complex environmental health and social issues did not fit. For instance, Mark did not feel that students could demonstrate a plausible link between pollution exposure and asthma rates with data they themselves collected. Many students chose projects such as, "What cleaner cleans shoes best," "Can you grow plants in soda," and "What kind of plant grows the fastest."

There are two issues here. Firstly, our priority was to engage students in science learning through bridging, rather than delving into specific scientific concepts. Secondly, the nature of the science we conducted did not fit the expectations of a science fair. Roth (1995) argues that unlike most school science,

"authentic science" is characterized by "ill-defined problems" and "uncertainties, ambiguities, and the social nature of scientific work" (p. 13).

Several students provided insight into how they learned. In two lunchtime interviews, students described their process of learning. This conversation grew out of Iyola, Charlotte and Latoya's comments on "actually going out on the street wise," experiencing things firsthand at Dignity Village, and hearing the homelessness activist speak. Latoya explained, "So when we study it it's basically make it factual by us making it a fact out of it by studying it and then going to see it by our own experience...Yeah, it [hearing the activist speak] was a very, very, very special moment...I think it's different from your looking in the book trying to remember everything you just learned. But when you are not reading in the book and you wanna have experience with it you get *visions*, you get to see how psychologically you visited it...I mean that we can go instead of studying it you get to see it *inside* our visions and emotions, how we carry it" (I9).

Latoya is explaining the deeply personal and emotional learning process that helps her to learn from experience. Learning from a book is about struggling to remember (many students talked about their struggle reading and remembering), perhaps because there is no experience tied to the concepts. Without experience, the learning is abstract or superficial, not fully digested. Listening to someone with first-hand experience, or seeing it themselves, allows the learner to have "visions" and make his or her own connections to the experience. Latoya's very personal and emotional perspective on learning resembles a constructivist perspective on

learning reminiscent of findings from Belenky, Clinchy, Goldberger and Tarule (1986). Latoya's perspective on learning offers another dimension of "streetwise" learning which I discuss in depth in my conclusion.

Conclusion

These findings answer research questions on participation, bridging and empowerment, as well as additional findings on conflicting beliefs between the teacher and students, language, and student learning. The teacher and I observed an increasing number of students participating in class as the community environmental health project progressed. Mark pointed out groups of students, socially marginal students, "highly skilled students who do nothing," and "low-skill" students, who were particularly enthusiastic about the project. Considering the gap between the school empire and the small student nation, I found it particularly significant that many students talked about what they were learning in the community environmental health project to their friends and family. The influence of students' ideas of respect and the right answer were examined in the context of who spoke up in class.

In response to my second research question, I discussed how personal/cultural knowledge and bridging was recognized in the data, and provided evidence for student bridging to scientific knowledge. Expressions of students' personal or cultural knowledge were characterized by: vernacular language, narratives that involved the student or his or her friend or family member,

narratives placed in settings such as their neighborhood, and expressions of emotions such as compassion, sadness, shame, pride, and outrage.

Bridging was recognized when students applied newly learned scientific ideas to expressions of personal or cultural knowledge. In the community environmental health project, bridging often took the form of students finding examples of environmental issues in their neighborhood, such as brownfields, asthma, diesel pollution, and water pollution.

Students' comments in interviews and in class helped Mark and I to identify aspects of the curriculum that facilitated participation, bridging and empowerment for the students: responsiveness and flexibility, putting local neighborhood issues at the center, giving students control over parts of the learning, talking justice, and providing public, creative outlets for students to express personal/cultural knowledge and scientific knowledge.

Findings on student empowerment described students expressing new roles and identities, and asserting themselves in new ways in the classroom and community. Students were eager to speak with neighbors, family members, and other students about what they were learning. Given opportunity to give presentations, write for the community newspaper, and create a program for community radio, students represented themselves as successful teachers of younger students, reporters, poets, scientists, and community activists. In their scientific autobiographies, many students made positive personal connections to science, and envisioned scientists as engaging in service to the community.

In addition to the research questions on participation, bridging and empowerment, additional findings that emerged from the study were discussed. These findings on the teacher's and students' views on science, pedagogy, learning, and language were described as part of a narrative of conflict between the empire of school and the small student nation. Issues of conflicting beliefs are central. The students' and the teacher's views of what should be learned and how it should be learned strongly contradict each other. Mark wanted student engagement and hoped to successfully cover his standard science units that involved more "sit and listen."

However, most students would not engage with "sit and listen." According to Kicheloe and McLaren (1998), school is defined by "resistance by students to the school's attempts to marginalize their street culture and street knowledge" (p. 275). Most students did not accept the ways of the empire that "sit and listen" represents: the validity of books and scientific expertise over direct experience, the use of scientific language without opportunities to translate it, and the passive role of the student in the classroom. Students wanted to learn in active ways that validated their epistemology and language. I found that students craved opportunities for empowerment in the classroom.

Language issues emerged as central in bridging between the empire of school and the small nation. The students mostly chose their own language over school language, but conceded the power of school or scientific language in certain contexts like City Hall. Data show how students started to translate from scientific

language into their own language. Additionally, some students saw issues of racial justice in the struggle between their language and scientific language.

I used student presentations, written assignments, and interviews, as well as the teacher's perspective, to examine what and how students learned. In presentations to younger students, many of the eighth graders expressed an understanding of concepts such as lichens as air quality indicators, the environmental justice geography of Portland, and the harmful effects of radon and lead. Some students talked about a new awareness of pollution, environmental racism, and their own neighborhoods. Additionally, some students offered insights into their very personal processes of learning from experience.

After describing the conceptual framework, the methodological choices, the curriculum, and the findings which emerged from the research, I now turn to the broader implications of the study. What kinds of changes do teachers and researchers need to make in order to fully engage students like the eighth graders at CMS in learning? How can students and teachers negotiate their two worlds? Are there more successful ways of helping students to access the wealth of the empire without betraying their own nation? In the next chapter I draw out my own views on the findings more fully. I use students' comments to form recommendations for science education and research.

CHAPTER VI

RECOMMENDATIONS AND REFLECTIONS

During the 2004-2005 school year I conducted a study in which the participating science teacher and I collaboratively designed, implemented, and evaluated a curriculum that solicits students' knowledge in the investigation of and action on community environmental issues. An action research methodology and qualitative methods were used to collect and analyze data to answer questions on student bridging of personal and scientific knowledge, and the relationships of this bridging to student participation and learning in science class. The most compelling themes from the data were described as part of a narrative of tension between the empire of school and the small student nation, of efforts at bridging the two nations, and of student empowerment.

The teacher and I collaborated to develop a curriculum that solicited students' personal and cultural knowledge as an attempt to build a bridge between the student nation and the school empire. The study found that the teacher's and students' views of what should be learned and how it should be learned strongly contradicted each other. The bridging was successful in that many students brought personal knowledge to class and many started to bring scientific knowledge into their personal worlds. Students translated between scientific language and their

own language, and they expressed an understanding of community environmental health issues in public presentations.

Most students participated more deeply and frequently in classroom discussion and completed more homework in the community environmental health project than in other parts of science class. This finding is at the same time encouraging and problematic. The curriculum was successful in bridging student knowledge and some limited scientific knowledge. However, our collaborative curriculum brought out latent tensions in the classroom around the students' and teachers different expectations ("sit and listen" versus "shake it out yourself"). After six months in our collaborative curriculum most students whom we had empowered and engaged still resisted the standard science units that the class was covering. Many students resented "sit and listen" more strongly after being engaged in the community environmental health curriculum.

Bolstered by research in critical theory and the equity gap, this finding suggests that in order to engage all students in science learning, teachers and researchers need to listen better to the students. We need to understand that students will not easily give up their way of knowing or their values, and adopt those of the school empire. Many will not engage as successful students unless they are respected and consulted in their education.

Minority culture students who have strong cultural identities will resist efforts by teachers to ignore or squash their ways of understanding the world. For these students, opportunities for gaining respect, for accumulating social capital,

and for participating in decision-making are crucial. Respect is the first step in the give-and-take of the classroom negotiations. Being consulted on their learning provides proof to the students that the teacher respects them and their ways of knowing. Valuing students' language is also central.

To shape an engaging and just science class we need to better understand the students' views on school, science, and learning. With this understanding of the students' world, the classroom can be shifted from a monologue to an active dialogue, from imposition and resistance to a successful negotiation between teacher and students.

This chapter offers recommendations and reflections based on this study. First I use the students' words to weave a set of broad guidelines for science teachers and educators in general. In other words, what is the small student nation trying to tell us in the empire about how we should teach and how students learn. Second I make specific recommendations for Mark, for science teachers and teachers in general, and for educational researchers. Third I offer directions for future research. This chapter closes with personal reflections on the process and results of the research.

From the Students' Mouths: Requests and Challenges to the Empire

The study yielded particularly rich data on students' views of learning, science, school, language, and other issues. When I took a step back to reflect on the findings, I started to hear students' statements as a set of integrated

recommendations. Taking a broad and creative look at what the students were saying, I see these statements as requests, challenges, and recommendations to us in the dominant culture: teachers, middle class people, researchers, graduate students, adults, white people. These recommendations reflect the experiences of the students who participated in this study – poor African American, Latino, and white middle school students – but carry relevance for all students.

I used the students' words for the core message of the six guidelines:

- "sit and listen,"
- "shake it out yourself,"
- "check this out,"
- "advertise it,"
- "nickname it"
- "word racism"

I used my knowledge of the context, the students, and the findings as a whole, to interpret what the students meant by each phrase. Appearing in *italics*, my interpretations of the messages behind the students' words flesh out these guidelines. Just as the students translated, or nicknamed, scientific terms into their own language for discussions with friends, in this chapter I translate, interpret, and expand on students' terminology for discussions with my colleagues.

These six messages were chosen because they emerged from the findings as the most representative, powerful, and relevant for this study. These messages are representative because, although the core phrases were spoken by one or two

students, the ideas and feelings they represent were expressed in different ways by many students over the course of the study. The power of these messages comes from their clarity and honesty, from their explanatory power. These messages are relevant because they speak directly to the core issues in this study: the equity gap, science education, participation, and learning.

"Sit and Listen"

Sit and listen is the voice the students hear from the front of the room. Our message to them is: *We teachers up here are not going to listen to you unless you students are saying what we want you to. Otherwise, stay still and follow our directions.*

I sense an undercurrent of disbelief and outrage in the students' statements about "sit and listen." What I hear the students are saying is: *Do you realize what you are asking me to do?* And that is the students' damning indictment of the schooling we give them.

What I found at CMS was a system that often squeezed teachers and students into narrow and painful roles. The student's role is to sit and listen and speak when spoken to, to do what they are told, to memorize things that other people discovered and wrote about. *Do not talk to your friends, do not talk about your life or interests, do not sing or drum on your desk.*

In science class, "sit and listen" means you are going to read and listen to things that other people already know about how the world works. *You students don't know the scientists who discovered this stuff. Somebody wrote about it in a*

language that isn't yours and you don't fully understand. Later you will be asked what you remember about what you read and what the teacher said. The students are the audience to our world, consumers of our knowledge. They are not actors, not producers of knowledge, and not experts.

In my head what I hear the students saying is: *We know that you think we don't know nothing. You want us to repeat back to you what you told us just like you said it. You want us to talk and write in big words. You won't let us express ourselves or do our own thing. You say we have to do all this to get an education and go to college and get a job. Most of us kids don't think about that stuff, or we don't believe it's gonna happen.*

From the teacher's perspective, "sit and listen" means: *This is the content I have to cover; there is a lot of it; my status at the school depends on how much and how well I cover the content, and this is the fastest, easiest, and most efficient way to do what I am told to do. It is not ideal.* Mark is dedicated to his students, and is restricted by the expectations imposed on him by the system, and the ones he has internalized: mandated content, behavioral control, high and low students, a science fair that is about what can fit on a posterboard and demonstrate in front of a passerby.

Hogan (2002) writes that domination, or power over, is ubiquitous in school. Perhaps the most fundamental of inequalities, according to Giroux (1992), is that students are not consulted in their education. Students are not asked what they want to learn, how they want to learn, or how classroom life should be

organized. Teachers need to guide, to facilitate this process, maybe they even get a veto, but there must be a dialogue between students and the teacher.

"Shake It Out Yourself"

"Shake it out yourself" means *I am going to go out into the world – the hallways, streets, rivers – and find out what is going on. I will be a detective, a journalist, a scientist.* What I heard the students telling us is: *We know how to learn; learning science is not so different from learning about what is happening on my block and I know how to do that.*

In their research on science in urban schools, Tobin et al. (2003) argue that the question of whether the teacher and students understand and value one another's culture is central to the relationships that underlie learning in the classroom. "Shake it out yourself" is an invitation and a challenge to the teacher and school: *Do you trust me? Do you respect what I know about the way it is?* "Shake it out yourself" means that firsthand experience is valued together with book knowledge. It means that oral tradition is as valid as written knowledge.

When a teacher allows and encourages students to "Go out street wise," it means that the teacher values the students' ways of findings things out. Stanley and Brickhouse (2001) write that the central question for multicultural science is: "Whose knowledge is of most worth?" (p. 38). The science teacher should answer the question "Whose knowledge?" loudly and clearly with "yours and mine." This is the opposite of saying, "sit and listen." We teachers and adults can come to the

students and say, *You know some things, I know a lot too. Let's figure out how are we going to learn some more.*

"Check This Out"

When students say, "Check this out" in their articles and teaching presentations, I can hear them explaining: *I've figured out some stuff, and I'd like to tell you what I know. Let me stand up there and tell it how it is. Pass me the mike. Let me get up on stage. Check this out!*

In this study, students became scientists, investigators, poets, activists, teachers, journalists, and rappers. We gave experiences, and some concepts, and an audience to whom they could say, "Check this out," or "That's not right," or, "Here's what we are gonna do about it."

"Check this out" means students want to express themselves in their own terms, in their own voice. They are claiming authority in the sense that P. J. Palmer (1998) discusses, "Authority is granted to people who are perceived as *authoring* their own words, their own actions, their own lives, rather than playing a scripted role at great remove from their own hearts" (p. 33).

We educators need to remember that when students tell it like they see it, it is not necessarily how we see it. It is often not expressed in tidy, grammatical school language. It may not fit our expectations of what science is. It may not be consistent or accurate. We adults, scientists, teachers entered into this agreement when we said: *Let's not sit and listen, let's shake it out ourselves and nickname*

things. Now we need to be willing to cooperatively reconstruct the nature of science.

"Advertise It"

When Ron and Terry told me that we have to "advertise it," I think that they were saying: *We need to put our message out in public in creative, humorous ways that nobody can ignore. If we think diesel particulate pollution in Northeast Portland is something everybody should know about, then we should do what advertising does; make it all over and make it catchy, something like TV commercials that you cannot ignore.* The students are also making an offer: *We* know how to do this. *We* can make people take notice. We could advertise anything, if we wanted to.

Ron's suggestion was, "A commercial. Like Geico....It smells like diesel particulates on this bus and it doesn't save anybody any money." Similar to "nickname it" and "check this out," "advertise it" means students expressing their learning on their own terms, in their own style and with authority. When I think of the conversations with Ron, Sheldon, and Terry about diesel particulates, I hear them suggesting to me: *Don't you know how things work, if you want people to know about it, you've gotta mess with people and be funny. They are not gonna pay attention unless you advertise what you know.* They are essentially putting out a request and a challenge, *Don't be boring.*

"Advertise it" comes from my last long conversation with Ron, Sheldon, and Terry. If we had more time, I would have continued to follow this line of

thought. I would ask the students to create advertisements for diesel particulates, asthma, brownfields, or any scientific concepts or information we thought needed to be advertised.

"Nickname It"

Once students shake it out themselves, we educators should build on their discoveries with scientific knowledge. This is part of the partnership that comes with bridging. Teachers want to apply scientific terms and concepts to what the students say they are seeing and smelling in their neighborhood. However, if students are going to accept and adopt science language and knowledge into their worlds, they need to be able to translate it into their own language. What the students at CMS were saying to me when they said "shorten it up" or "nickname it" was: *If you want us to really use the big words, you gotta let us do it like we do it.*

In their work on critical multicultural science education, Barton and Yang (2000) write that the goal is to find "mutual accommodation between science education and children and youth from the inner city" (p. 887). When the students want to "nickname it," in my head I hear them saying: *This is a process of negotiation. We will take science if we can rename science, if we can make it our own. We will talk about diesel particulates with our friends on the bus, but we will call it "DP." The atmosphere can be pretty boring but if we say "the lit" instead of 'lithosphere,' then it's O.K.*

With "nickname it," students are also saying that learning on their terms is fundamentally a social activity. What they meant was: *We've got to talk to our*

friends and family and people on the street. This is a reminder to adults, to teachers of the importance of the students' social world in their learning process.

However, I also see in "nickname it" students' reluctance, and in some cases outright refusal to give and take in these negotiations. Students are eager to translate science in their terms but less eager to translate their language into scientific terms. Perhaps because they are holding out, thinking: *Until you (adults, scientists, teachers, city hall) accept my language, I won't accept yours.*

"Word Racism"

"Word racism" is the students' way of recognizing and putting a name to the injustice in the world. Terry coined the phrase and Ron later used it to describe not being listened to by people in power unless they used "big words." In these discussions about "word racism," I hear the students saying: *They won't listen to me. That's not right. They are trying to shut me up.*

Students are passionate and articulate about what is not right. When students were confronted with people who lived next to a military dump dying of cancer, or kids and teachers at the old toxic school building getting sick and nobody doing anything about it, they were quick to call out, "that's not right!"

"Word racism" reflects the students' struggle with making sense of injustice in their world. Students are insisting that we take injustice seriously in our teaching and learning. I see here both the students, mostly African American and Latino, drawing on their personal and cultural experiences of being mistreated, and Mark and I figuring out how to make the rules of society explicit in the classroom.

The students are also asking for help in how to understand injustice in the world and how to take action to pursue justice. When we bring up the issue of language and power (for city hall "my bus stinks" or "diesel particulates") we must find ways to help students learn, to help them feel empowered, and not discouraged. Mark and I were not able to take this learning any further. If we had continued, an activity such as writing letters and preparing presentations to City Hall which incorporated both students' language and scientific language would help students move between the worlds. It may help them to begin to right the injustices they see around them.

We need to help Terry get to the point so he does not feel discouraged when he tries talking on the bus about diesel particulates and nobody listens. We need to help students speak their minds and keep talking when they encounter indifference or injustice. When students call out "word racism," we need to support them to confront the tensions in society and gain a sense of agency. Freire (1998) writes that we are "conditioned" by our historical and social context but not "determined" by it (p. 26). In other words, in expressing agency, we place ourselves in our social and historical context and choose to change it. As with "nickname it," I also hear a stalemate in the negotiation: *If you won't listen to the way we nickname things, we won't use your language.*

Taking Students' Voices Seriously

We need to take students' voices seriously. We must demonstrate to marginalized students that their ways of knowing and learning are accepted in the

classroom. We must find ways to help students find fluency in scientific language while not forcing them to abandon their own. In other words, we must act as if school was not an empire but a federation of autonomous peoples that agreed to learn together without giving up their values and identities.

The students must be prepared to negotiate and collaborate as well. Although I think the teachers must take the first and perhaps the bigger steps because of their power, we need to hold the students to their side of the bargain. In other words, once students feel respected in that their world is valued in the classroom, the teacher must thoughtfully insist that the students step into the world of science. This is Delpit's (1995) exhortation to progressive white educators (like myself); we must give marginalized students full access to the majority culture, in this case, science.

If students chose homelessness or graffiti as the subject of inquiry and action in science class, we need to widen the boundaries of science to accept their choice. In the dilemma of whether students should draw their own maps or use the more accurate city maps for presentations, we need to take the time to help students draw their own maps that are accurate enough. This means accepting when students nickname scientific language and at the same time challenging them to be fluent in science.

Concluding Thoughts on Learning with Mark

Because this was a collaborative study that embodied research *for* practice rather than *on* practice, this section reflects mostly lessons that Mark and I learned

together over the course of the study, rather than a list of new recommendations. Through the process of planning, enacting, and reflecting on our work in the classroom, Mark gained new ideas for engaging students, new perspectives on his students and his neighborhood, and a critical awareness of his teaching. These brief suggestions represent the last entry in a long log of conversations, written analysis, questions, and reflections that Mark and I engaged in. These recommendations are rooted in and emerge from Mark's own practice and the joint practice we constructed.

My four recommendations for Mark are: (a) find ways of bringing student power and interests into the mandated science units, (b) partner with community health or environmental organizations to develop relevant projects for students, (c) make issues of conflicting language, knowledge, and power explicit in the classroom and, (d) cultivate a professional support network to help with the pressures, contradictions, and complexities of teaching

Mark commented several times that there was no way he could put together the resources for this project on his own. I recommend partnering with a fellow teacher or agency that could supply the necessary background logistical support for getting students involved in local issues. The challenge is in finding an organization that does more than organize one-day tree plantings or canned presentations.

Graduate education or science students at Portland State University, outreach staff at Bureau of Environmental Services, Oregon Health Sciences University's Center for Research on Environmental and Occupational Toxicology,

or the Environmental Justice Action Coalition could provide the connections that Mark needs in the community. Connections to Street Roots and KBOO Community Radio were also important for providing students with creative public outlets. Ideally, staff at the partnering agency could help by providing information on current issues, organizing field trips and speakers, and providing equipment. In the last week of our work together I provided Mark with a list of these contacts and resources.

I recommend that teachers talk openly about the negotiations in the classroom. At the beginning of the school year, the teacher's and students' expectations of science learning should be put up on the board and discussed. The message: "The things I know and the things you know are both important. We will be balancing this all year. Sometimes I will ask you to read in books to find out what others have learned. Other times I will ask you what you want to learn about and how you want to learn about it."

When language issues arise, I recommend Delpit's (1995) suggestion that two columns be made on the board, one for student language and one for scientific language, or the students keep this list as part of their science glossary. Issues of "word racism" and power embedded in the two languages should be discussed in class. I think at least a brief discussion of responses to injustice would engage the attention of the students.

Because of the success of the community environmental health project and the disjuncture between the project and geology, astronomy and climate units, I

recommend finding ways to bring the students' interests into the mandated science units. We can raise student participation and improve learning by including elements of student choice in the curriculum, by having students translate scientific terms into their own language, and by giving students the opportunities to give public presentations.

Mark and I did not discuss professional learning and support as an important aspect of Mark's work as a teacher. However, as was discussed in the findings, Mark struggled with balancing his pedagogical ideals on the one hand and the professional and institutional expectations on the other. Mark made it clear to me that one of the benefits of this study was raising his awareness of the impact of his choices in the classroom.

Continued support for Mark, like any teacher, is crucial for him to continue to learn and grapple with the incredible pressures and complexities of teaching. Specifically, a structured continual learning process might help Mark to bridge the gap between the ideal and the convenient. In the course of our collaboration, Mark identified several challenges in his teaching. A structured process based on teacher-led professional growth offers the opportunity to examine and take on challenges in the classroom, such as falling back on convenient pedagogy. The most useful and immediate support could come in the form of a community of teachers learning/reflecting together. Professional learning communities and "Courage to Teach" groups come to mind as possibilities. Expanding to a broader level of

generalization, the lessons for Mark mirror the recommendations for all science teachers.

Recommendations for Science Teachers

I have four primary recommendations for science teachers. These are particularly relevant for those who work with poor and minority students but are meaningful and helpful for all teachers: (a) elicit and amplify students' personal and cultural knowledge in the classroom, (b) collaborate with students in the learning process, (c) help students to create new ways of participating in science and, (d) collaboratively reconstruct the nature of science and science learning.

Although it was not a focus of this study, Mark's identity as an African American may have played a significant role in the collaborative curriculum, and in students' comfort with sharing personal and cultural knowledge. White teachers may have to work harder to gain the trust of minority students, particularly around issues of culture and language. However, I believe that the recommendations based on this study are applicable to all teachers.

Elicit and Amplify Students' Personal and Cultural Knowledge

In the course of this study I found Aikenhead's (2002) statement that teachers are "cultural brokers" to be hugely significant. As cultural brokers we need to become aware both of science as cultural knowledge and of the many student cultures. Teachers need to develop a trusting relationship with students and develop norms around classroom respect so that students will feel comfortable candidly sharing their perspectives in the classroom.

There are many ways that teachers can ask students to share their personal and cultural knowledge on issues related to science – a science with broad boundaries. Using the students' personal lives and neighborhood experiences provide a great context for these conversations. Students' knowledge can be amplified by displaying it around the room, creating stories, songs or presentations. Inviting students' own language into the classroom and helping students to translate from scientific to vernacular has great potential for student engagement and learning.

This does not mean that teachers focus all the learning on students' interests. Because teachers have authority in the classroom and because minority cultures have been marginalized, the teacher needs to make the first steps into the students' world. Once the students' knowledge is on the table, it is the teacher's job to bring the disciplinary knowledge to the table. As Sutherland (2002) advises, teachers should openly discuss power, epistemology, and the two kinds of knowledge.

Collaborate with Students

Eliciting and amplifying student knowledge is the first step in the partnering that includes involving students in curriculum choices and ultimately in reshaping science. This means together with the students deciding on what to learn and how to learn it. Teachers can help students to develop parts of the curriculum, to write their own assignments, to choose presentations or written reports. This study found that flexibility is a key to engaging students in decision-making in the classroom.

For most teachers, collaborating with students will involve giving up a significant amount of power in the classroom. The fear of uncertainty and chaos is a powerful disincentive. In this study and others, uncertainty emerged a central challenge for teachers (Blumenfeld, Krajcik et al., 1994; Ulichny & Schoener, 1993). Fusco (2001) writes, "Although I was unsure how science was emerging from these initial conversations and activities, it was important to my methodology that the young people provide leadership in our activities together, that our activities came from their interests, experiences, and concerns" (p. 868).

This study found that many students were not willing to accept aspects of school science. Bridging students' interests and scientific learning is a complex collaboration that involves teachers playing multiple roles. The teacher needs to provide a significant amount of structure and active facilitation. Particularly in the beginning, the teachers may have to give up more of their expectations to bring student knowledge and power into the classroom. However, once students are engaged, teachers must demand that students also compromise and accept aspects of science and the empire of school.

Create New Spaces for Being Scientists

In place of the lab-coated research scientist, landscapers, mechanics, nutritionists, or community activists can be held up in the classroom as people who use science. We can help students create new settings for science in their own communities rather than the textbook or lab. These examples and settings help students to expand notions of science and to imagine how they themselves might

participate in science; this is central to empowering students as science learners and as community members. Partnering with the community can help provide a bridge between students' personal knowledge and scientific knowledge

We need to give students opportunities to be experts, teachers, poets, activists, or researchers. Public expressions that combine a student's cultural creativity with scientific learning are great spaces for students to participate in science.

These events can also generate excitement and serve as important sources of social capital for students. Tobin et al. (2003) stressed the importance of generating "positive emotional energy" in science class to promote participation. Building social capital means accessing cultural, academic, and other resources through social networks (Mullis, Rathge, & Mullis, 2003). For example, presenting scientific learning to younger students is an opportunity to gain respect in the eyes of peers and the teacher.

Through participation in scientific activities such as the KBOO radio group, students built new relationships with other students. Tobin et al. (2003) argue that these social networks from doing science become a source of agency for students, opportunities that can be accessed in out-of-school settings. Wonderful opportunities for learning and empowerment arose from students from CMS joining KBOO's youth radio program, or volunteering with the Environmental Justice Action Group. Students were remaking science as they participated in it in new ways. I see reflected here Lave and Wenger's (1991) situated learning

perspective that considers learning as part of engagement in social practices. Through the practice of creating a radio program, the students generated and negotiated meanings of science, and new identities as student leaders, reporters, and scientist/activists.

Reconstructing Science Together

The findings of this study lend strong support to the need to reconstruct the purpose and nature of science education. Extensive research has described objectivist, elite Western notions of science as a part of the reason for an equity gap in science education (Aikenhead, 2002; Barton, 2003; Sutherland, 2002; Taylor, 1996). When science learning is mutually constructed by the students and teacher, students who were not interested may be encouraged to participate.

The process of defining with the students the issues to be investigated and the methods to be used, the focus on local issues, the new types of scientific activities, are all ways to invite students to redefine science as something that matters to them. They are a set of activities in which students could be involved. However teachers need to expand their definitions of what counts as science.

Fusco (2001) wrote about her work with poor minority science students, "I began to think that what we were creating was a human science – a study of our world and ourselves" (p. 865). My data supports Fusco's finding that given the opportunity, students framed science as a humanistic effort. Fusco (2001) writes that the students and teacher created a non-Western view of science that was "socially oriented rather than task oriented" (p. 873). Additionally, teachers must

be prepared to confront political issues related to science. This study found that students were drawn to issues of justice in the investigation of community environmental health. Science became closely linked with sociopolitical action (Roth & Desautels, 2002).

This is not to say that all students will conceive of science in specifically these ways, but that the historical definitions of what counts as science must be expanded by young voices, by multicultural voices. In this process, teachers must offer their expertise and authority in ways that do not drown out student voices but also push the students beyond their own experiences (Floden & Buchmann 1993).

This study found that the conflict between the disciplinary and institutionally mandated boundaries of science and co-constructed science poses considerable challenges. Ways to balance the two sciences will emerge as science teachers start the process of collaborating with their students and researchers present themselves as allies in this process.

Once students are given the opportunity to express personal knowledge, collaborate in the curriculum, and reconstruct science it will be difficult for teachers to return to "sit and listen" pedagogy. Particularly once students are empowered through a collaborative approach, they will quickly recognize and resent being forced into a more passive role.

Recommendations for Educational Research

This study provides additional evidence on the need for critical and multicultural science education, for constructivist pedagogy, for correcting the

fundamental inequalities of schooling, and for involving educational practitioners as collaborative researchers.

In the process of conducting this study, I became committed to several significant aspects of education research: long-term partnerships with teachers, attention to relationships, the potential of action research, and researchers' roles as a third partner in the teacher-student dynamic. Even though I spent almost two school years with the same teacher in the same school, I feel like our relationship and our work together have just begun. Several issues arose that we were not sure how to handle. In the spiral learning process of action research, additional rounds of planning, enactment, and reflection led to a more thorough, thoughtful, and effective program . To enact useful innovations, researchers must ground themselves in the context of the school, the teacher, and the students

Researchers can play important roles as collaborators. Particularly in embattled schools such as CMS, researchers can act as critical support for the teacher and the students. Being able to offer another perspective, resources, and insights that come from prolonged observation and participation can empower teachers and students and improve learning for all. Like the teachers, researchers must give also give up control. Rather than evaluating teachers and imposing expertise, the collaborating researcher should provide rich data, ask insightful questions, and offer resources.

I agree with Angrosino and Perez (1998) that ethnographers must view students not as subjects but collaborators. After conducting this study, I believe

even more passionately that research should be committed to "practical significance over methodological sophistication" (Kemmis & McTaggart, 1998, p. 592).

Directions and Questions for Future Study

This study filled some significant gaps in the literature on issues of knowledge, language, science and the equity gap, community-based and project-based science with urban minority students, student participation, and on collaborative innovations. This study provided insight into the students' world, and the possibilities and challenges of bridging that world to science learning.

From the point where this study leaves off, there are a number of significant directions and questions that call out for further study. I discuss lines of questioning following directly from this study, how ethnographies and curriculum studies can inform science education and offer methodological implications for further study.

Where This Study Left Off

In this study, students were adept in describing the school empire and pointing out the injustices in the negotiations. Do students recognize their complex roles in the negotiation process? Do they see the ways in which their resistance or acquiescence impacts the classroom and their life in school? What would have happened if we had gotten further in our project and the students were able to translate back into science from their language? After bringing the students' knowledge into the classroom and amplifying their voices, would they be willing to travel farther into scientific ways of knowing?

Delpit (1995) insists that educators give marginalized students access to majority culture. In this study we focused our efforts on getting students to the table, on eliciting their knowledge. What would it take in terms of curricular activities, time, etc... to bring these students deeper into the world of science?

Giving students a voice in deciding what was learned and how was an important aspect of this collaborative project that was not fully explored. What is the role of student participation in decision-making in issues of equity and learning? What happens when students, particularly those resistant to schooling, are given the opportunity to participate in decision-making in the classroom?

This study was conducted with eighth graders. How are issues of competing cultures and epistemologies expressed in high school students? As students grow older, how do their views of schooling and science change? Do similar issues exist among poor students? How does gender play into the negotiations between the small student nation and the school empire?

Perhaps one of the most pressing questions that remains in the wake of this study concerns balancing collaboration with students and the demands of science content. How can student-led curricula be balanced with the demands of mandated science content? Are there ways of enacting co-constructed community science and preparing students for the expectations of high school and college science and standardized testing? Are the two approaches fundamentally contradictory?

Based on my findings there exist fundamental differences between a student-led, collaborative approach and mandated science content. However, if the

teacher is conscious of student interests and values, able to cultivate a respectful classroom, geology and astronomy units can be taught in ways that engage marginalized students. Even in the mandated units, students can be given ways of participating that appeal to them: public presentations, hands-on work, translating scientific terms into their own language.

Several researchers (Barton 1998, Seiler, 2001) have documented successful informal, or extracurricular, science learning programs with marginalized students. The findings of this study ("shake it out yourself" and the KBOO radio lunch group, for instance) confirm the power of giving students ways to participate in science outside of the traditional science classroom. These findings raise questions about the relationship between informal, out-of-the-classroom science learning, and what the students experience in the science classroom. If extracurricular programs are conducted in collaboration with teachers, how might they help students participate in science class? Rather than bringing out latent tensions in the classroom between the students' and the teacher's way of understanding science learning, how could these programs be structured to serve to support and push both teachers and students toward constructive collaboration in the classroom? These are ripe directions for future studies.

Ethnographies and Curricular Studies

To solve the equity gap it is crucial to better understand how particular communities understand and participate in science. This is where classroom and community ethnographies have great potential to inform work on science

education. What are potential areas for collaboration between science and urban African American and Latino communities? What are the cultural traits and adaptations in various student cultures, genders, and socioeconomic classes that can be used to promote learning in the classroom? How can students' linguistic creativity be used in science class? How do the students' cultural identities compete with or compliment budding science identities?

There is a paucity of research on Latino cultural identity and adaptation in the context of science learning. Are there bridges that exist for Latino students between their cultures and science learning? How do Latino students perceive science in relation to their identities as students and community members? What does it mean for teachers to be able to bring multiple cultures into the science learning?

In terms of curriculum, many questions remain about developing guidelines and curricula that make connections to students' personal and cultural knowledge. What would it look like to create, collaboratively with students, science curricula that spoke to their cultural knowledge and identities? How could cultural traits such as verbal creativity in the African American community be used in curriculum development?

Based on this study, I think issues of language play a significant role in student participation and learning. I have yet to see science curricula that recognize and utilize the tensions between scientific language and students' vernacular language.

The balance between planning a curriculum and being responsive to students' needs demands attention in educational research. Can student empowerment be achieved with a preplanned curriculum? In other words, are there elements of student-led, community-based science curricula that can be included in existing curricula, or does the importance of collaborative flexibility mean that too much preordained structure will derail the process of getting students engaged?

Ethnographic methodologies can be used in conjunction with the development and evaluation of culturally relevant science curriculum. The kind of data that ethnographies generate can be useful for teachers and researchers testing out learning activities. Evaluation and assessment tools can tell you what students did or did not learn, but ethnographic data can help get at the complex set of reasons for what's happening inside and outside of the classroom.

In learning activities that solicit students' interests and choices, what kinds of participation in community-based science do students seek? How do students construct science identities in culturally-relevant science curricula? In community-based science learning, how do students view their roles in the community? How do teachers understand their new roles in student-led curricula?

Based on my findings I think that issues of student identity could offer valuable directions for study. How can we help marginalized students to create positive science identities? How does the culture of the classroom need to change to allow for the creation of new student identities? What roles do cultural identities play in the development of the student's sense of self as a science learner?

Methodological Directions

The ways in which research is conducted are as important as the research questions themselves. To generate research that is rooted in the context of classrooms and directly informs practice, to empower teachers and students to make changes, collaborative research is central. I found that long-term collaborations that pay particular attention to relationships have the potential to catalyze change in the classroom. The goal of research in the classroom is not evaluation but insightful description combined with questions that uncover tensions and possibilities.

There is considerable research that decries the failure or "dilution" of educational innovations (Bouillion & Gomez, 2001; Huberman & Middlebrooks, 2000). Collaborative studies that examine and support classroom innovations hold much potential to improve practice in the classroom. I agree with Krajcik et al., (1994) that the primary ingredients of successful innovations are collaboration, enactment, and reflection. A supportive and at the same time challenging collaboration between teacher and researcher can be the means of understanding the teacher's knowledge, beliefs, and context, as well as the catalyst for changing them.

Researcher-teacher relationships should be models for the teacher-student relationships. Our theoretical approach should be mirrored in our methods. In my work this means reflecting collaboration, empowerment, and social transformation in the way I interacted with Mark and the students. This conceptual framework and

these methodological choices enabled me to express my identity through the research. In my time at CMS and in this narrative of my study, I strive to find the authority that happens when I author my own words (P. J. Palmer, 1998); when I integrate my inner voice with my work with students and teachers.

How do the recommendations of this study apply in classrooms where there is no outside catalyzing agent to offer support and momentum? I think that the role of teacher-to-teacher collaborations has much potential to support the kinds of changes science teachers need to make to teach to marginalized students.

Concluding Reflections

Fine and Weis (1998) and Goodnough (2003) write about the importance of the researcher engaging in self-reflection, a discussion of the impact of the findings, of the researcher's identity, of bias and tensions in the research. This "second-order inquiry" (Goodnough, 2003, p. 41) enhances the ability of the reader to understand the study, helps to bridge the theory and practice gap and improve the practice of researchers, and ensures more thoughtful and democratic collaboration. Reflecting on what I learned as a researcher, my challenges and biases, my multiple roles and relationships, as well as questions of validity emerge as central.

One of the challenges that emerged for me repeatedly during the study was learning to be descriptive and not evaluative in my data collection and analysis. To collect quality data, I needed to make detailed observations, rather than allow my gut response (i.e., "that was disrespectful") to overwhelm the specific observation (what was said, in what context, etc...). The structure of the data collection and

analysis process I used helped me to stay close to the data and to separate out my gut responses. I used my responses and judgments in analytical memos in my extended data log to better understand my bias and to reflect on my multiple roles as a researcher. At the same time, the multiple roles and spiral process of action research allowed me to use my perceptual and relationship strengths.

Particularly in my work with Mark, I had to learn how to have constructive conversations about what I observed in the classroom, not to avoid tensions in the data, but at the same time to be thoughtful and not impose my views. Through many conversations with doctoral candidate Susan Stein and many faculty members, and through my own continual process of reflection, I learned to provide Mark with relevant data and ask questions that helped both of us gain a better understanding of what was happening in the classroom and what we should do. I learned how to draw analysis and ideas from Mark and to support him to bring out his ideals.

Where we had disagreements, I tried to let go of control, not to use my academic authority to impose the theoretically "correct" decision. This is the same approach I advocate using with students. When we disagreed about whether students should create their own maps or use prepared maps, Mark, as the teacher, made the final decision. We later used this disagreement as a way of talking about the tensions between the two sciences and our own roles and beliefs.

Learning from our disagreements is an example of the critical theory approach that Kincheloe and McLaren (1998) call "self-conscious criticism" (p.

265); to better understand how our own thinking and behavior act as limitations to our full self-determination and participation in social transformation. Part of my self-determination as a researcher, a teacher, and an activist is to better understand my assumptions and bias.

For example, it was easy for me, as an intellectual activist and as a critical educator, to see the ways in which the school system, the administrators and sometimes Mark played the role of the oppressors. This view of an oppressive school system fit with my assumptions, and could cloud my observations in the classroom. My bias as a progressive educator and a member of the Jewish middle class pointed easily to the faults in the system, and found compassion for the students, and even Mark, as victims of an unjust system.

I had trouble acknowledging the ways in which Mark and the students themselves play self-destructive roles that perpetuate that same system. Since I see myself as an activist, a critical educator cultivating empowerment in my work with teachers and students, it was easy for me to deny the examples of entrenched passivity, dependence, or powerlessness. Because of this bias it was harder for me to see the ways that students, teacher, and myself, were implicated in our own oppression, how we limit our own and others' self-expression.

It was difficult to observe how entrenched certain patterns were: Mark's constant frustration with administration and students, and the students' refrain of "I don't know." Mark's pattern did not lead to deeper awareness of his work as a teacher or help him to improve his practice. The students' response of "I don't

know" was self-denigrating, did not give the teacher much information about the students' learning process, and did not serve to inspire the student to participate in class. These non-constructive patterns are examples of what Freire (1995) characterizes as adapting to rather than shaping the world. Adapting is the opposite of acting as a "subject," the opposite of expressing agency.

At times it was a struggle for me to rise above the tedium of school life and find redeeming moments. At other times, I saw the tremendous potential of Ron, Terry, and Latoya. In understanding and checking my bias it was helpful to look at my experiences in the different roles I played.

In the year and a half I spent at CMS, I was both constrained and empowered by my multiple roles as participant observer, as collaborating curriculum developer, as teacher's assistant, as ally to students, as an activist, as an adult. I felt the stifling pressures of the patterns and roles at the school: the teachers' and administrators' reliance on coercive power over the students, student acquiescence, anger and resistance, teachers' frustration with students, parents and the administration, and the students' ability to shut out anything an adult authority figure was saying to them. Most of the students at CMS were African American or Latino, and most of the teachers and administrators were white. At times I felt squeezed into my role as a(nother) white, adult, authority figure.

I remember telling my friends and family that CMS is a painful place to spend time because it is not a place to have healthy human interactions such as talking about what matters and being listened to, working cooperatively toward

shared goals, joking and laughing. The school presented multiple obstacles to Mark and I enacting our educational ideals.

On the other hand, there were many times when I felt the power of my role as a catalyst for change. Because I developed good rapport with many students and was able to hone my questions and methods, we had meaningful and constructive conversations; both the students and I left with new understandings of our situation and of the choices we were making as teachers and students. This is the kind of knowledge produced by participatory research and characterized as "knowledge with emancipatory relevance" (Wals, 1994, p. 22).

Particularly the conversation with Ron, Terry, and Sheldon about the students' social world, scientific language, and word racism, and with Charlotte, Latoya, and Iyola on the personal nature of learning as "shaking it out yourself" were full of social critique, self-awareness, and emancipatory relevance. I am thrilled with the buzz we created in the community environmental health project; providing new opportunities in science learning, and empowerment in the classroom and community. I am confident that the insights Mark gained into his own practice will feed his work as a science teacher for many years to come.

The conversations with Mark and the students, Ron decrying the injustice of word racism in his article in Street Roots, and Andrianna rapping about air pollution in the school hallway are the final proof of the validity of this study. Methodological rigor in clarification of bias and ensuring data quality was my

responsibility. My deep hope was to achieve the action research validity that addresses social transformation.

According to Carr and Kemmis (1986), participants must gain authentic understandings of their situation that help them make decisions about a course of action. I helped students and Mark to seek justice and self-determination at CMS. This is the goal of my conceptual framework and methodological choices, the "workability of the actual social change activity engaged in" (Greenwood & Levin, 2000, p. 97). Clearly, my work is a drop in the ocean, but a drop with ripples.

In moments of broad reflection on my time at CMS, I find myself returning to two religious teachings. Firstly, I think of Martin Buber's (1949) conceptualization of "I and Thou." Buber describes the ideal relationship as one in which both individuals see the other as a whole being in the center of his or her own circle of existence. The challenge is to see the student, Latina, teacher, homeless person, not as a generalization, or a number, or a person of "high" or "low" ability, or as a means to our educational end, but as a whole being in her own right.

Imagining myself at CMS, where I felt like I was at the junction of so many injustices, I hear in my mind a passage from Deuteronomy 16:20, "Justice, justice you shall pursue" (Jewish Publication Society, 1917). A traditional Jewish interpretation of this passage explains that the word justice is repeated because we should be just both in our means and our ends.

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APPENDIX A

STUDENT INTERVIEW GUIDE

Student Interview Guide

1. Tell me about what we are doing in science class.

2 How do you like it? What do you like about it? What don't you like?

3. Do you like to raise your hand and answer questions or offer your ideas in class? Why/ Why not?

4. Why do you think some kids like to raise their hands and others don't?

5. Do you think it is important to study stuff that's going on in your neighborhood? Why/Why not?

6. How are you doing in science class? Are you learning stuff? Like what?

7. Do you like science? Why or why not?

8. Do you want to learn more science? What kinds of science? Why?

APPENDIX B

TEACHER INTERVIEW GUIDE

Teacher Interview Guide

1a. Do you think that the changes you have made this year (eliciting students' knowledge, investigating community issues) have helped your students to learn science concepts?

b. What concepts?

c. What was it about the program that helped them to learn these science concepts?

d. How do you know they have learned it?

2a. Has student participation changed at all? Who participates? When? What they say?

b. What do you think helps or hurts meaningful student participation in class?

c. What signs do you see of shifts in student participation?

d. Have you observed students making connections between their personal or cultural knowledge and scientific knowledge?

3. What are the major challenges in what we are trying to do in this study?

4. What has surprised you about how things are going?

5. What have you learned from your experience in our study (the new things we are trying, the process of action research) about teaching science with these students?

6. How could we improve on what we are doing in terms of student participation and learning?

APPENDIX C

EXTENDED DATA LOG

Extended Data Log

1/10/05 CMS OBSERVATION

6th-Period Observation
(22 students, 8 boys)
Latoya "Can I read you my poem" (to SFS and Mrs. Yanola) says something so fast and so much slang that I do not understand anything except "They're sweating her about it at home" Mrs. Iyola explains.
Almost all students want to write poem or draw picture, noone wants to write essay or article except for Trina and Anna (their personalities in school). Students write/draw stuff with drugs, profanities- Izzy "You don't like that part" SFS "it's not appropriate for school." Sergio is gone to different school.
Eshana about her poem "This is tight" (shrugs her shoulders up and down to a rhythm). M sits at desk, walks around twice checking in with students, sits on table.
SFS "It would be great if students could organize the data, tables, etc…" M "we just don't have the time to spend on that" Compromise- we organize data on table and give it to students to analyze. M agrees they should learn to analyze, make connections.
Many students chat quietly, look at each other's poems. Yolanda and Arianna sit silent, "I don't know what to do. I don't want to write for the paper" Yolanda silent.

7th-Period Observation
4 absent
Terry gets Mary to smell his arm pits. Toby pushes himself around in chair with wheels. Juan gets Daniel to fill out his homework survey.
Terry (unsolicitied comment) "I interviewed this one dude and he asked if air pollution keeps getting worse than in 30 years are we all going to have asthma."
Cherie (unsolicited comment) "I could smell air pollution when I walked to me class. We have to walk outside to get to class."
Terry (unsolicited) talks about chemical accident he saw on news, does not know where or exactly what. M nods to each comment, "interesting' or "alright."
All but 5 did homework survey
SFS "what did you think of doing the survey?" Terry "I liked it because I was on the street and went up to this guy. He was like 'what!' and then he gave me the answer. We got some nice people in our neighborhood." Don "It was tight. It was fun. How I got to interview people."~STINTPUB
M writes down survey answers on overhead, students give answers from survey.
Juan did not do homework. Chews his finger, adjusts pant leg, messes with Mrs. Iyola. Gal silent. Andriana "There's this tree in my yard and it had lots of lichen on it. That's what I did for my homework" Toby shows me his lichen survey "Is this right?"
M "It looks like principal will not be leaving." (disappointed)

We talk about gender split. M says it is well documented- boys don't do work, behavior problems.

2/22/05 CMS Lunch Interviews

Ron, Terry, Seth, Sheldon
SFS intro- no grades, anonymous.
SFS "what did you think about doing the presentation"
Terry "They got bored quick. You running out of stuff to stay to them so you got to make up stuff that didn't even happen- I was like, back in the day cavemen used to scrub their teeth with it, used to take baths with it"
SFS "did you enjoy that"
Terry "It was kind of fun"
Ron "They should have more activities. All they wanted to do was do things. I think they liked the one thing where we had to go outside with the lichen and all that"
SFS "Dow did you like being the teachers"
Seth "pretty fun. Control the kids a little bit" laughter from Ron and Terry
Terry "I liked the fact the kids was younger than us so we had like an older influence on them. If you said something they probably listen to it or if you said something and they didn't belief it but they could ask someone about it...like if you got some big lichens around your house that means you got good air around your house they didn't believe that. They thought that you had to test the air with a special thermometer."
SFS "So they didn't believe you but you still thought you had some older influence" Terry "They didn't believe me." SFS "what did you like about having that older influence?" Terry "I felt in charge." Ron laughs
Sheldon "It was kinds fun but they don't even pay attention they wander off because we was running out of activities. They part they probably enjoyed the most was going outside and looking at the trees which they didn't pay attention to but it was kind of fun anyway" SFS "What did you like about it" Sheldon "To see how I act in class not to see how like Mr M said that they way they was acting that is how we act in class. So now when you try to teach somebody something, like when I try to teach them they was just wandering off, when my teacher start to teach me I just wander off so now I see how my teachers feel, so that makes me want to do better in class. I think that's why we did it though"
Ron "It was kind of annoying because you know how teachers give you time outs, when they wasn't paying attention I felt like giving time outs because of what they was doing to me man" (laughter) "They was just talking. ((Little kid spit)) I knew if I got mad at them I would have gotten my respect but I couldn't do that"
Terry "My kids they wasn't really bad they wasn't moving a lot but when you tell them something they wouldn't really look at you so they don't think they heard, so I had to bribe them with money, if you answer questions I give you $5. He raised

his hand and got the question wrong...he said do I still get my money for raising my hand"
SFS "Do you ever talk about ir pollution, asthma with family or with friends or family" Terry "I aksed my mom how many people in my family had asthma and she was like just about everybody except for me and her and some other people. Most of my family smoke and stuff, that's probably one of the biggest reasons they got asthma and like when they smoke they move around a lot, they active they get short breathe real quick"
Terry "I talked about air pollution with my neighbor lives around the corner from me. He was like, he worked at this one, like place, I forgot what's it called" Sheldon "he build tiles" Terry "Yeah, he build tiles, and the stuff when he be cutting it the dust goes into the air and like people like inhale it it migh mess with they lungs and stuff so that's a different type of air pollution that everybody else might not experience but it can happen" SFS "That's cool you talked to him" Sheldon "Today in class I smelled air pollution" SFS "Yeah I remember" Sheldon "It was strong like burnt tires...some my friends they underaged drivers they like to do get in their car and burn rubber but sometimes I tell them not to do it because that cause a lot of air pollution, but sometimes I encourage it because you know you got to be at a party sometimes you gotta show off" SFS "Seth?" (silent) Terry "Seth, you aint said nothing" Ron "I asked my mom or my dad I forgot, those people that make those cigarettes why do they keep on making them if there people that are buying it die, they losing people" Terry "They losing customers" Ron "Yeah" SFS "You are right." Sheldon "I was at home thinking about what cause the most air pollution, I think a volcano- that's like a bunch of cars combined together."
SFS "Do you guys usually talk about school with family and friends" "yes," "NO" Sheldon "only when I am bored I bring up stuff that happened at school...like I asked my aunt, she lived down the street--she asked me what I learned if its good she give me $20 if its bad she give me $5, but if I tell her nothing she give me $1" Terry "something me and my son" Ron "my son Terry" (laughter) "My son Ron just never gets enough" (laughter)
SFS "How is that stuff (surveys, air pollution) is it different, how?" Terry "Wa, no in science class mr M makes us read from a book and gives us a work sheet, that's a good way to learn like but it get boring real quick ((books, worksheets)). Personally the only reason I did the survey was because it was fun. I like walking around to random people I don't know on the street and asking them questions" SFS "You liked it cause it was fun?" Terry "Yes" Ron ((field trips))
SFS "You guys are smart and a bunch of you guys failed, right, why don't you guys do homework?" Sheldon "first of all when we get science homework its not science around our neighborhood around the neigh, we do nothing but play basketball, fight, play fight, and talk to girls. Mostly half the time when your parents asked you if you have homework for science you lie tell them no then you try to hurry up and get it down in the morning, but half the time you just leave it on

your kitchen table or it aint fully done" Ron "I think they should have homework that's interesting to do like so experiments and all that." Terry "Its not experimental its straight out of the book. I don't like to do nothing straight out of the book because I don't like reading and looking for answers. The reason for example that I don't like doing science work is say he like gives us questions out of the book, you gotta take the book home you gotta be responsible for the book you cant leave it at home, you leave it at home you gotta pay for it. If he gives us experiements ((water thing and boat)) I like them. It was fun"
Seth "Im just busy, get carried away. Kind of like going outside." Ron "They should give us work they we can go outside and all that."
SFS "Last time, diff kinds of language, big s words, professor" Terry "Diesel particulates" SFS "Exactly" Terry "I hate that word, don't nobody know what diesel particulates are. Remember me you and Matt, alright we was on the back of the bus and I was like "This bus smells like diesel particulates" SFS "Really did you really say that" Sheldon "He did, he said it to the bus driver" Terry "I said this bus smell like diesel particulates and everybody just got silent and they didn't say one thing (emphasis) " Sheldon "and they he felt all stupid" Terry "I was like, aww." Sheldon "We have to get off the bus" Terry "They didn't say nothing it was like they was belittling my word cause I was a kid" SFS "Who?" Terry (loudly) "The grown people" SFS "who wa the grown people on the bus?" Terry "everybody on the bus- yeah Trimet" Terry "Don't people like myself deserve respect" SFS "You didn't feel like you were getting any respect?" Terry "No, they didn't say nothing, they just kept on rollin" SFS "What were you hoping they would say?" Terry "I was hoping they would say 'aw really" (laughs) I was hoping that other people was going to agree with me like people sitting next to me and stuff, I was hoping they would be like 'yeah this bus does smell like diesel particulates, maybe they didn't know what diesel particulates was cause they didn't say nothing, so I feel like we the only people that know what diesel particulates are. I should have been like this bus stink and they would have been like 'yeah this bus do stink'" SFS "I hear you, we talked about certain situations when it might be useful, city hall)(())" Seth "Maybe when you get a job, trying to be proper" ((who thought about air pollution))
SFS "Other thoughts on language" Ron "I think they should shorten it up...and advertise the word" Terry "like DP, it smell like DP on this bus" Ron "Yup" (laughs) Ron "I gave him that idea bro" Terry "no you didn't" SFS "Why do you want to shorten it up?" Ron "Cause, man when they advertise it on the bus...make commercial" Terry "advertise DP" Ron "Like Geico and all that" Terry "This bus smells like diesel particulates and it doesn't save anybody any money" (laughter)

Analytic Memo: Negotiation between cultures, language, shorten up, science lang. Building social capital: approaching strangers, talking to people on bus- looking for respect. Science learning to build social capital 1. outside of school- respect (Tobin), speaking with strangers, knowing what parents don't know (pilot), 2.

respect from $6^{th}/7^{th}$ graders in presentation "I felt in charge" "older influence." Building social capital and respect has to do with age (p. 82, 4) STDISREADING, BRIDGING, experimenting with science language- but failed to build social capital on bus! Did we set them up for this failure? Students gain understanding of teaching and self-understanding as students through presentation. More activities in sc class.
AXIAL Coding: codes connected to RESPECT: STSILFEARPEER, SCSERVCOM, STINTPUB, STTALKJUST, WORDRACISM, STRESISTTE, STSHAMECMS, STEXPRIDE, BEINGSMART, COMGOODBAD.
Methodological Memo: I chose 1 student for interview, that student chooses 2 friends- better dynamics, more conversation, honesty

APPENDIX D

DATA CODING NOTES

Data Coding Notes: Examples of Coding and Developing a Theme

EXAMPLE 1: List of Codes and Citations in Data Log

STPERSCON: Student makes connection from personal knowledge to science class (p. 1, 17)(p. 7, 45-46 add 12/20) (p. 8, 29-30) (p. 10, 16-17) (p. 20, 45-46), (p. 22,2-3,19-20) (p. 24, 25-26) (p. 24, 33-34), (p. 27, 3-4, 23-31) (p. 26, 13-14, 21-22) (p. 40, 1, 5) (p. 41, 17-19, 19-21, 33-34) (p. 42, 8-9) (p. 45, 43-45) (p. 46, 18-19, 19-20) (p. 47, 13-17, 25, 30) (49, 10-12) (p. 50, 5-6) (p. 51, 9-10) (51, 13-14) (p. 51, 14-17, 17-18, 48-49)

EXAMPLE 2: Axial Coding

Initial Coding:

BEINGSMART: (importance of seen as being smart in class)
STSILFEARPEER (student silence because they fear peers laughing at them)
STSHAMECMS (students express shame about being students at CMS)
STEXPRESSPRIDE (students express pride in selves, or neighborhood)
WORDRACISM ("word racism": being mistreated/disrespected because of the words you use)

Axial Coding
Theme of Respect

After looking at the properties of these codes in the context of the data, I saw that the codes overlapped strongly around the theme of respect: being respected or disrespected by peers in class, feeling disrespected by the public by being a student at CMS or using certain language, and feeling that one's neighborhood deserved respect. The theme of respect was central in the development of the narrative of the Empire of School and the Small Student Nation.

EXAMPLE 2: Axial Coding

Initial Coding:
STEMPOWER (Students express empowerment: knowledge tied to plan of action)
STLIKPRES7th (Students like giving presentation to seventh graders)
STINTPUB (Students interested in public parts of class)
STTALKJUST (Student talk about justice)
STTALKAWARE (Students talk about gaining awareness)
STUNSOLCOM (Student raises hand or offers unsolicited comment)

Axial Coding
Theme of Student Agency

APPENDIX E

STUDENT WORK

Get to know your neighborhood:

Name:

Address*: Morgan*

Major cross streets*: Dekum, Alberta*

Nearest Park*: Woodlawn*

Closest bus lines: *9, 75, 8*

Businesses within blocks*: Yong's market*

1. Walk all of the blocks in your three-block neighborhood. Write down 5 specific observations that relate to the issues we have learned about in class (air, noise, water pollution, environmental health, transportation, lead, garbage, etc…) and where you made your observation.
    - *On 5th and Dekum there is graffity on walls*
    - *23rd and Morgan there is a lot of trash*
    - *24th and Annsworth at Alberta Park can sometimes be filthy*

2. Ask 5 people in your neighborhood these questions:

    What environmental issues do you see in our community?
    - *I see fighting which young kids should not see*
    - *I see people making bad choices against others*
    - *People littering now there is trash everywhere you go*

    Do you ever get sick from problems in your surroundings?
    - *Yes*
    - *Yes*
    - *Yes*

    What would you like to change about the environment in our community?
    - *Less graffiti and people making better choices. Less trash*

    How could 8th grade science students improve the environment here?
    They can improve by walking a few blocks to pick up trash and then guess how much trash is on the ground all over the world.

CHOOSE EITHER TRAFFIC COUNT OR TREE COUNT

3. Stand right in front of your house and count the number of cars that pass you (both directions) in 5 minutes.

   95 cars went past my house

4. Walk around your block and count the number of street trees (trees planted in between the sidewalk and the street are street trees).

   I seen 28 trees planted on the sidewalk

5. (Extra Credit) Choose another one of the ideas that we had in class, and follow through (check newspaper for community issues, call City of Portland, ask a scientist or community leader, observe industrial areas.) Put your notes below.

Three things that come to mind

1. *What is going on couldn't they see that people were getting sick*
2. *I did not know carbon dioxide made headaches*
3. *how could they let this be*

Three things that surprised me

1. *that people are dead because of lung cancer*
2. *that there was carbon dioxide in the school*
3. *that this was more than 10 years*

Man they should have tried to find out why all these people were getting sick and it was more than 10 years so they really needed to find out they now that that was wrong so they should have just told the board. Than the windows did not open so they really were in trouble. And all them students were in there how they let the radon get so high and all them kids were in that school my sister was coming home ever day because she was getting sick.

homeless people

how does it feel to be homeless?

It feels really crappy, because you don't know what to do or where to go, or where to spend your money on especially if you're an addact.

What decisions did they make to become homeless?

They could of lost there job's and had no money and didn't know where to go. So they turned to the streets.

Are people who are poor crazy?

No. poor people are not crazy they might look crazy because they have nasty clothes and dirty hair and nasty teeth. But they are not crazy.

Science Autobiography

If I were a scientist I would try to stop pollution. Pollution is unsafe to kids and adults. I personally hate it because I have asthma. I would also work to help prevent the ozone layer from breaking, because I don't feel like dieing at a early age.

If I were a scientist I would help prevent a lot of things to help this world.

Words from [redacted] Middle School

This fall and winter, 8th grade science students at [redacted] Middle School learned about environmental health issues in their community. Students conducted community surveys and neighborhood observations that they themselves designed. One class chose to learn more about air pollution and asthma, and one class chose to learn about homelessness. The following articles, poems, raps and drawings were created by these students for street roots. Thanks go out to [redacted], the 8th grade science teacher, and Shamu Fenyvesi Sadeh, a graduate student at PSU, for supporting the students in their work. Here is a selection of their work, with more to follow in coming editions. Thank you, [redacted].

I Think If I Would've

[redacted]is

Every day from dawn to dusk,
Dusk till dawn, I think of my
Life, and all the strife, I think if I would've
Stayed in school, I probably wouldn't
Feel like a fool, I think if I would've
Kept playing ball, I might not be
Sleeping behind malls, and I think
If I would've thought, I probably wouldn't
Be lying on this block.

Street Rhymes

[redacted]

I don't know what just happened in my mind.
Was I just studying street crimes or was I studying rhymes?
My saying is just so spicy that they just want to pop out and bite me.
Out of an historical action, life is a study.
You never know how and what you're going to get out of it
'cause you give in and you give out.
Streets...they're deadly 'cause every chance you get,
you never live to see your family
'cause of the chances of diseases, crack, meth and ecstasy.
People steal your chance of making it
and they also steal the glory of what you had
and tried to tell you you didn't have it.

Dignity Village

[redacted]

Recently, Mr. Moule's 8th grade science class went on a field trip to Dignity Village, a small community for the less fortunate. "I've never considered myself homeless. Earth is my home," said Tim McCarthy, treasurer and member of the village. On the field trip, Tim showed everyone around, showing us how they use different things to help them with their needs. They use car

Street Roots, March 15 2005

Words from [redacted] Middle School

This fall and winter, 8th grade science students at [redacted] Middle School learned about environmental health issues in their community. Students conducted community surveys and neighborhood observations that they themselves designed. One class chose to learn more about air pollution and asthma, and one class chose to learn about homelessness. They both choose to write their thoughts down for street roots. We ran the first installment of their writings in the March 1 issue of street roots. Here is more of their comments. Thank you, [redacted].

Air Pollution

Air pollution. What is air pollution? It is something that causes disease throughout the country. That's something I know. I think it harms people's bodies. When people burn coal, it causes lots of air pollution.

We all need fresh and clean air to breathe; and not just us, but animals, too. People and children who have asthma can be affected by the dirty air and we can start coughing badly.

Air pollution is also caused by cars, trucks and smoke which comes from factories. And how can we stop this? We hardly can cure this. If we try to cure it, we just have to let people go away from this world.

People who have diseases can even die from air pollution. People who live near factories can have bad times smelling the smoke coming out of the factories. I think factories should stop the smoke.

In air pollution, there are lots of chemicals and bacteria. I don't like air pollution and I don't think anybody does. It causes lots of problems. In the United States, there are lots of kinds of air pollution, but not in other countries.

[redacted]

■■■

I think it's not fair 'cause old buses give asthma. Or why do you have to say a big word to get City Hall's attention? How can they clean one place and not finish it? When I did a survey, the people who have asthma live in a polluted community. Surveys are a way to get the facts. They should advertise EJAG (Environmental Justice Action Group) to help pollution. What surprised me the most is that most of the people I surveyed said that they could often smell air pollution. It's like when I go outside, you can really smell the gasoline near my house.

[redacted]

■■■

Hey, my name is [redacted] and I go to [redacted] Middle School. We're here to talk to you about air pollution. What do you think causes air pollution? If you don't know, check this out. Everywhere in Portland you can smell it; even in your own house and your own car. Do you ever wonder why people get sick from it? It's because of the factories around your house. So if you, your family members or friends have asthma, you would think that it was from a factory or your own car that you drive in.

[redacted]