10-2014

Science Identity Transformations Through Place-Based Teaching And Learning In The Natural World

Amy DeFelice
Graduate Center, City University of New York

Recommended Citation
DeFelice, Amy, "Science Identity Transformations Through Place-Based Teaching And Learning In The Natural World" (2014). CUNY Academic Works.
https://academicworks.cuny.edu/gc_etds/415

This Dissertation is brought to you by CUNY Academic Works. It has been accepted for inclusion in All Dissertations, Theses, and Capstone Projects by an authorized administrator of CUNY Academic Works. For more information, please contact deposit@gc.cuny.edu.
SCIENCE IDENTITY TRANSFORMATIONS THROUGH PLACE-BASED TEACHING AND LEARNING IN THE NATURAL WORLD

by

AMY DEFELICE

A dissertation submitted to the Graduate Faculty in Urban Education in partial fulfillment of the requirements for the degree

of Doctor of Philosophy, The City University of New York

2014
This manuscript has been read and accepted for the
Graduate Faculty in Urban Education in satisfaction of the
dissertation requirement for the degree of Doctor of Philosophy.

Dr. Jennifer D. Adams

____________   _________________________
Date     Chair of Examining Committee

Dr. Anthony Picciano

____________   _________________________
Date     Executive Officer

Dr. Jennifer D. Adams
Dr. Kenneth Tobin
Dr. Gillian Bayne

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK
Abstract

SCIENCE IDENTITY TRANSFORMATIONS THROUGH PLACE-BASED TEACHING AND LEARNING IN THE NATURAL WORLD

by

AMY DEFELICE

Adviser: Dr. Jennifer D. Adams

This dissertation includes three main components related through a sociocultural lens of identity transformation. The first component describes the Field Studies program for ninth grade students at Brooklyn Academy of Science and the Environment (BASE High School), and explores how outdoor settings and place-based pedagogies can be used to enhance urban students’ science identities. Student researchers took digital photographs of their Field Studies experiences and met in cogenerative dialogues with me, their teacher, where we shared our reflections. The second component explains students’ experiences and reactions to a week-long place-based geoscience program held over spring break at Prospect Park. This program was offered to BASE students through the Opportunities to Enhance Diversity in the Geosciences (OEDG) National Science Foundation (NSF) grant awarded to Brooklyn College. Student researchers completed pre and post surveys, participated in focus groups, and wrote written reflections in their science journals to reflect upon their experiences completing authentic science research projects with undergraduate students and college faculty. Survey results were paired with students’ journal responses to understand students’ science identity transformations. The third component focuses on a case study that emerged from the Field Studies research. The dialogues between a female Caribbean American high school student and myself, a female white science teacher, are explored using the lenses of critical race theory and identity to focus on themes of stereotyping, whiteness, and science interests. This research adds to the body of knowledge describing how
outdoor settings and place-based pedagogies can be used to increase urban students’ interest in science. Additionally, this research investigates how in multicultural urban schools it is important for teachers to understand not only their students of color, but their own identities, and the relationships between them, in order to appropriately support their students’ interests and desires to enter Science, Technology, Engineering and Mathematics (STEM).
ACKNOWLEDGMENTS

First, I would like to thank my advisor Dr. Jennifer D. Adams for her patience with me, reading countless drafts of this manuscript, and supporting me all the way. Thank you to Dr. Kenneth Tobin who introduced me to Jenn as a main advisor, and to Dr. Gillian Bayne, for serving on my committee. Thank you to Dr. Brett Branco, Dr. Jennifer D. Adams and Pieranna Pieroni for their collaborations with publishing Chapter 3, Engaging underrepresented high school students in an urban environmental and geoscience place-based curriculum, in the *Journal of Geoscience Education* publication. I also want to thank the other students and professors in the Urban Ed program for teaching me so much. Thank you to my students and colleagues at BASE, BBG and PPA, for opening my eyes and inspiring me to want to be a better teacher. To my parents, Janet and Michael, thank you for your encouragement and always believing in me. Thank you to my brothers, Michael and Jonathan who were my first “science partners” exploring nature at the cottage every summer. Also, thank you to Helen and John for the support and countless hours helping with the kids. I also want to thank my children for showing me how to be a better teacher by being a parent. Finally, I especially want to thank my husband John for his continuous support in this process. I can’t wait to see what’s next.
Dedication

To my children, and “my kids” at school.
# TABLE OF CONTENTS

| ABSTRACT | .......................................................... | iv |
| ACKNOWLEDGMENTS | ............................................... | vi |
| LIST OF TABLES | ....................................................... | xi |
| LIST OF FIGURES | ....................................................... | xii |
| CHAPTER 1- INTRODUCTION | ................................................. | 1 |
| Context | .......................................................... | 3 |
| Formation of Brooklyn Academy of Science and the Environment (BASE) | ........................................ | 3 |
| BASE Field Studies | .................................................. | 5 |
| Field Studies as a living curriculum | ........................................ | 7 |
| Theoretical Framework | ............................................. | 7 |
| Identities | .......................................................... | 8 |
| Place-based Education | ............................................. | 8 |
| Whiteness | .......................................................... | 9 |
| Hermeneutic Phenomenology and Cogenerative Dialogues | ....................... | 10 |
| Authenticity of This Research | ........................................ | 11 |
| Overview of the Chapters | ........................................ | 12 |
| CHAPTER 2- TEACHING AND LEARNING IN THE NATURAL WORLD | ...................... | 16 |
| Place-based Environmental Education | ........................................... | 17 |
| Place and Sense of Place | ............................................. | 21 |
| Identity | .......................................................... | 25 |
| Encouraging Science Identities | ........................................... | 28 |
| Implications for Place-based Education | ........................................... | 30 |
| Methodology for Understanding Field Studies | ........................................... | 30 |
| Cogenerative Dialogues for Reflection | ........................................... | 31 |
| Digital Photography | .......................................................... | 33 |
| Field Studies Program | .................................................. | 34 |
Reflections for Understanding

Learning About Students’ Field Studies Experiences

Transforming Senses of Places

My Sense of Place

Bringing the Field Studies Experience into the School Building

Science fair reflections

Developing a Sense of Place and Appreciating the Beauty of Nature

Sense of Place at the Botanical Garden

Is Field Studies Place-based Education?

Challenges and Recommendations for the Field Studies Program

Lessons Learned Through Field Studies

CHAPTER 3- ENGAGING UNDERREPRESENTED HIGH SCHOOL STUDENTS IN AN URBAN ENVIRONMENTAL AND GEOSCIENCE PLACE-BASED CURRICULUM

Encouraging Interest in Science

Pedagogy of Place

Sociocultural View of Learning

Designing Place-based Learning Experiences

Research Experience Program

Soil Compaction

Algae Blooms

Research Teams

Pairing Survey Data and Student Journals

Being a Scientist: Identity in Participation

Connecting Students to the Science Community

Place-based Science Education

Self-identification as Scientists

CHAPTER 4- UNDERSTANDING SELF THROUGH OTHERS AND OTHERS THROUGH SELF: EXPLORING SCIENCE IDENTITY DEVELOPMENT AT THE INTERSECTION OF RACE AND GENDER
Identities and Awareness of Women of Color in Science, Technology, Engineering, and Mathematics (STEM).................................................................................................................................80

Conceptual Framework........................................................................................................81

Identity.................................................................................................................................81

Women and Women of Color in STEM.............................................................................82

Whiteness............................................................................................................................82

Case Study Using Cogenerative Dialogues.....................................................................84

Reflections for Understanding..........................................................................................85

The Specter of Stereotypes.................................................................................................86

What does a scientist look like?.........................................................................................90

What does a good teacher look like?................................................................................93

Using Race as a Lens and as a Mirror...............................................................................95

Encouraging Interests While Recognizing Challenges.....................................................101

Identity of Place: Cynthia’s Caribbean Connections.......................................................103

Becoming White................................................................................................................105

Transforming Interests in Science as Women.................................................................108

Intersections of Race, Gender, and STEM......................................................................114

CHAPTER 5- HIGHLIGHTING CLAIMS WHILE RECOGNIZING CONTRADICTIONS..119

Authenticity Criteria..........................................................................................................120

Key Claims..........................................................................................................................123

Shifting Perceptions of “Research”..................................................................................130

Conclusions and Further Directions..............................................................................136

APPENDICIES....................................................................................................................138

A. Survey.............................................................................................................................138

REFERENCES....................................................................................................................143
LIST OF TABLES

Table 1. Strands of Science Learning.................................................................26
Table 2. Student Research Activities for the Week-Long Research Experience........66
Table 3. Student Findings and Recommendations.............................................68
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Students using dip nets</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Snail found in leaf litter</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>New leaves</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>Lullwater bridge</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>Walkway</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>Reflections on pond</td>
<td>47</td>
</tr>
<tr>
<td>7</td>
<td>Binnen falls</td>
<td>48</td>
</tr>
<tr>
<td>8</td>
<td>Cynthia’s initial scientist drawing</td>
<td>91</td>
</tr>
<tr>
<td>9</td>
<td>Cynthia’s second drawing of a scientist</td>
<td>92</td>
</tr>
</tbody>
</table>
CHAPTER 1 - INTRODUCTION

Place-based science education considers students’ multiple ways of knowing about a place and has the potential to expand students’ science identities by engaging students in real-world science experiences in places that are familiar to them (Boullion & Gomez, 2001; Calabrese Barton & Berchini, 2013; Lim & Calabrese Barton, 2006). Focusing on place can help change the discussion of urban science education from one of problems to one of possibilities (Calabrese Barton and Berchini, 2013). The purpose of this ethnographic research is to learn about the teaching and learning and science identity formation and transformation of student participants in a ninth grade Field Study class that incorporates a place-based science curriculum at Brooklyn Academy of Science and the Environment (BASE). Over a one year period, I engaged in cogenerative dialogues (cogens) with my students where their digital photographs of class events were structures for reflexivity and narrative development of their experiences with science in the Field Studies class. Student narratives of events during the Field Studies class were constructed and analyzed within a sociocultural theoretical framework to determine expression of student science identity transformation. Sociocultural theory around identity formation was used to consider the overarching research question: how are urban students’ science identities transformed by a place-based environmental education curriculum?

Following an emergent design, this research led to an investigation of a week-long, place-based geoscience curriculum enacted during a vacation and in partnership with Brooklyn College and the Prospect Park Alliance (PPA), and a case study of how a Caribbean-American female student’s science identity intersects with my identity as a white female science teacher using a lens of critical race theory. The week-long geoscience curriculum became a topic of inquiry for me because Brooklyn College faculty designed the curriculum in collaboration with BASE
teachers, students, and landscape managers from Prospect Park. BASE students were invited to apply for the geoscience program because of the school’s partnership with PPA. I was currently a teacher-researcher at BASE and this project was of interest for my inquiries of informal place-based science education. The case study research emerged because Cynthia, who was a student-researcher in ninth grade, continued to share her science experiences with me in tenth grade. Cynthia raised the issues of race and gender in science which led me down the path of studying “whiteness” (Frankenberg, 1993).

This study is important because it explores the engagement of urban high school students and teachers in place-based science education in both formal and informal settings, where science teaching and learning is focused on local places and issues. This research also addresses the continued underrepresentation of women, and particularly women of color in completion of STEM baccalaureate degrees and careers (NSF, 2010; Ong et al, 2010). As I explored the transformation of students’ science identities through their learning experiences in the Field Studies class at BASE I also considered my shifting identity as an urban science teacher while I reflected on my whiteness vis-a-vis my students of color. There is a dearth of research describing whiteness in urban science education and this inquiry is novel in that it explores this topic from my perspective as a white female teacher engaging in discussions of race and gender in science with my students. I describe the development and benefits of planning place-based curricula for students through the school’s partnership with two community organizations, Brooklyn Botanic Garden (BBG) and Prospect Park Alliance (PPA). This study adds to the literature supporting place-based science education approaches for transforming science identities. I hope that it can be a resource for educators, administrators, and community organizations that are interested in
establishing or improving their own place-based science education programs, as well as add to the discussion of how race structures experiences with science.

Context

Formation of Brooklyn Academy of Science and the Environment (BASE)

The New Century High Schools (NCHS) initiative includes eighty-eight New York City public schools and nearly 40,000 students (Hirota, Highes & Chaluisan, 2008). The initiative was started in 2001 to create new small schools to replace large failing high schools. The Small Schools initiative was sponsored by several not-for-profit foundations such as the Bill and Melinda Gates Foundation, Open Society Institute, and the Carnegie Foundation. Funds were administered through New Visions for Public Schools, acting as the Partnership Support Organization (PSO), because private foundations do not directly give money to the Department of Education (DOE). New Visions for Public Schools has worked with the organizations involved in the public educational system to rethink how public high schools can be internally restructured (Hirota, et al. 2008). The goal of the partnerships is to “support the social and developmental well-being of students while promoting their intellectual growth and academic achievement” (Hirota, et al. 2008). BASE is a New Century High School that opened as a new “small school” with 125 9th grade students in 2003. BASE is a New York City public school with open enrollment and is partnered with Brooklyn Botanic Garden (BBG) and Prospect Park Alliance (PPA).

BASE is a partnership between PPA and BBG. Both of these organizations have similar philosophies of environmental and science education and since neither organization offered many high school programs that supported environmental stewardship or science they had
discussions about forming a high school to fill this void. The New York City Department of Education (DOE) set up a planning team for BASE that consisted of seven teachers, key representatives from the partner organizations, the principal, parents, and a student from the park’s Youth Council. The planning team met over a period of a year to plan the school’s theme. PPA and BBG are embedded in the curriculum at BASE through the Field Study class, in addition to supporting youth development, such as providing extracurricular clubs like the Young Naturalists and the BASE Garden Crew, adding strength to the partnership. (P. Fishman, personal communication, December 1, 2008)

At the time of this research, BASE had approximately 575 students and was composed of approximately 80% students of African descent, most self-describing as African American or Caribbean American. The remaining ethnicities included 10% Latino/a, and 10% Middle Eastern students. Since approximately 80% of students were on free or reduced price lunch, it is classified as a high-needs school. The mission statement of BASE High School was developed with PPA, BBG, and DOE employees. The BASE High School mission statement reads:

BASE is a three-campus New York City Public High School that integrates the missions and resources of Prospect Park and the Brooklyn Botanic Garden to offer academic excellence and rigor. Our community of staff, families and community partners supports students in becoming critical thinkers, active learners and problem solvers who are scientifically literate, engaged citizens who value and respect the environment.

The partners and their missions are referred to in the BASE mission statement.
BASE Field Studies

The BASE Field Studies class is the strongest example of the partnership between BASE, PPA and BBG. PPA and BBG provide a Field Studies educator and a part time Field Studies assistant to co-teach the class with the BASE science teacher. All ninth grade students take the Field Studies course concurrently with a Living Environment course (an integrated biology content course) that leads to a state-wide assessment. The Field Studies lessons are somewhat aligned with content in the Living Environment course. For example, in the fall, Field Studies investigates topics in the Living Environment curriculum such as abiotic and biotic factors of an ecosystem, food webs, and plant and animal adaptations in the ecosystems of Prospect Park. Students attend Field Studies class once a week with their Living Environment teachers and a typical session is 2-hours long. During a typical session, I meet my students and the Field Studies assistant at the school and we either walk or take a school bus to BBG or Prospect Park. We meet the Field Studies educator and assistant who have materials ready for our class at a designated location. The Field Studies educator and assistant organize the materials required and help plan for the weekly lessons with the BASE teachers. Many of the activities planned for students incorporate cooperative learning strategies where students have roles and work in small groups to complete the assigned task. Students are dismissed from class at the exit to the park or garden.

During the winter months the Field Studies is held indoors in the classrooms, education greenhouses, and conservatories at BBG. Students participate in lessons focused on plant adaptations, plant reproduction, and seed dispersal in different ecosystems all topics well-supported in a botanical garden. Over several weeks students observe plants in the desert, tropical, temperate, and aquatic plant conservatories. Students observe leaf litter in the native flora garden and use dichotomous keys to identify evergreen trees at BBG. Students also help
design and carry out a controlled experiment on factors affecting seed germination by exposing seeds to different conditions such as soaking them in salt water, fresh water, scratching with sand paper, and exposing them to fire (teachers used the flames). During these activities, students act as scientists to plan, conduct, create graphs, analyze their results and present their findings from the controlled experiment. This is an opportunity for students to engage in an inquiry activity where they take on the role of scientists, and enact their science identities to answer a question about seed germination. The majority of the outdoor lessons are held in Prospect Park during the fall and spring seasons.

In the spring, students design and conduct science fair projects. Students’ projects usually focus on determining human impacts on Prospect Park. Each Field Studies class takes a class vote to determine which ecosystem; either aquatic, forest, meadow, or urban, will be the focus for their classes’ science fair projects. The class all focuses on the same ecosystem to make managing student data collection in the field possible during class time. Students brainstorm with guidance from teachers regarding what materials are available and what topics can be completed in the four-week (class meets once a week) time-frame for data collection to determine a menu of different projects. Students also spend one to two weeks planning their projects and three weeks analyzing data and completing their science fair projects. Students select their top three topics to research and teachers determine cooperative learning groups of four students based on student requests. One particular classes’ projects focused on the aquatic ecosystem in the park and included: observing and comparing water chemistry at four different locations to determine the health of the ecosystem, collecting and observing macroinvertebrates at different locations to determine the biotic indexes, collecting and observing plankton samples and comparing with water pH at those locations, and identifying and surveying water fowl.
Field Studies as a living curriculum. The Field Studies curriculum is planned by the Brooklyn Science Academy teachers, the Field Studies educator and assistant hired by the park and garden, the education directors for the botanical garden and urban park, and the school’s principal, who has a science education background. Field Studies teachers from the school and the Field Studies educator and assistant have planning meetings throughout the school year. We also have a whole day “retreat” style meeting in June at the end of the school year with the teachers and education directors of the partner organizations to plan and assess the Field Studies course. Because the class does not end in a state exam or standardized test teachers have a lot of flexibility in designing the curriculum. We are able to revise lessons and projects and improve our teaching and learning based on experience and student feedback. This provides us with the opportunity work in a true community of practice and be “knowledge producers” in terms of curricula and activities we develop to meet particular learning goals. In this context our experiential knowledge, or knowledge gained on the job as teachers, is valued and respected (Kincheloe, 2004). To incorporate a more place-based education perspective we incorporated a theme of “human impacts on the local park” into the lessons and students’ spring projects were geared toward monitoring human impacts in different ecosystems.

Theoretical Framework

Urban science students often face a disconnect between the content that they are learning in the science classroom and their lived experiences. This can potentially cause students to become disinterested in science because they do not see the importance of science in their lives (Basu & Calabrese Barton, 2007; Brickhouse, 1994). In this research I used a sociocultural framework of identity along with theories of place-based education, and a critical race theory of whiteness, to study science identity formation and transformation and science teaching and
learning. I felt that by studying identity transformation I would be able to determine how students experienced the place-based curricula and in turn be able to better link their lived experiences to science learning. I also used the critical race theory of whiteness to understand my own race and gender in relation to my students.

**Identities**

Identity development is a process; it is ongoing and occurs in relation to the fields of culture in which we interact. Our identities are formed as we learn culture and find ways to meaningfully contribute to a given field of culture or community (Stetsenko, 2008). We each have multiple aspects to our identities; however, we will enact different aspects depending on the field of culture, the resources, schema and practices we have access to at the time (Bourdieu, 1993; Sewell 1992). Science-related identities refer to individuals’ sense of who they are, what they believe they are capable of, and what they want to do in relation to science (Brickhouse & Potter, 2001). Pursuing science here is defined as developing knowledges about the physical, biological, and social world through observing, questioning, seeking answers through designing experiments, and reflecting on experiences. Through this research I hoped to determine influences on students’ science identities because students’ future pursuits in science related fields may depend on their science identity formation and transformation.

**Place-based Education**

Place-based education engages students in cross-curricular, or multidisciplinary, methods where knowledge is co-constructed through hands-on, real-world learning experiences (Gruenewald, 2003). The local community and environment are the contexts for student engagement in language arts, social studies, mathematics and science learning (Sobel, 1996). A
place-based teaching and learning approach to environmental education increases students’ understanding of the physical, cultural, historic and socioeconomic meanings of local places (Semken, 2005). Connecting student learning to place is a way to motivate science learning, empower underrepresented communities, and make greater connections between the school curriculum and the students’ lifeworlds (Buxton, 2010; Calabrese Barton & Berchini, 2013). In many science classrooms teachers are often expected to follow a set curriculum. Using students’ relationships with a place may locally differentiate the curriculum and provide more authentic learning experiences for students (Gruenewald, 2003). Since places are multidimensional entities whose meaning is formed as people interact with them, individuals will experience places differently and science educators can bring these multiple perspectives into the classroom to better understand a given place. Incorporating place into the science curriculum can allow students to bring their own ontologies into school science experiences where students can confirm their existing identities and bring their local ecological knowledge to science learning experiences (Adams et al., 2010). Science educators should also be reflective of their notions of place and how their identities affect their understanding, or sense of a place.

**Whiteness**

Whiteness goes beyond the color of one’s skin, and is more than an ethnicity, but is a powerful, society-shaping force (Kress, 2009). Whiteness is generally enacted on an unconscious level as behaviors are compared to a “white norm” (Kress, 2009). This normative discourse oppresses those outside the dominant culture and can silence those with less power (Rodriguez, 1998). Frankenberg (1993) notes that white women are “race privileged” and are not in a structural position to see the effects of racism on our lives or in U.S. society. White women who are not exposed to diversity often do not pay attention to issues of race since they do not consider
that they are racist and therefore they feel they do not have to concern themselves around race-related issues (Frankenberg, 1993). As white people in the United States hold political and economic power, this apathy maintains the racist system that is currently in place and results in maintenance of the status quo. Critical Race Theory recognizes that white racial power is maintained over time in America through white privilege and white supremacy, marginalizing people of color (Kincheloe & Steinberg, 1998). When many white educators like myself begin teaching in diverse settings, they are not aware of racial power dynamics, or institutionalized racism, and may feel society is “color-blind,” meaning all racial identities are treated equally. Through exposing white educators, like myself, to the social power associated with being white, they will begin to recognize their racial privilege and possibly feel racial discomfort, which may result in forming a new racial identity. Coming to an awareness and constructing a new white identity will not erase the power differences between whites and non-whites (Kincheloe & Steinberg, 1998). However, learning about whiteness and coming to an awareness of power issues associated with being white can improve white educators’ teaching and learning as they are better equipped to see how their racial identity affects their students. Upon forming new racial identities, white educators might be inspired to take action to ameliorate racial disparities so that one day we can achieve racial equality.

Hermeneutic Phenomenology and Cogenerative Dialogues

As a researcher I came to this inquiry with my own conceptual perspectives, life experiences, research experiences and guiding research question. I used hermeneutic phenomenology (van Manen, 1990) to surround my stories and my students’ stories with meaning. Cogenerative dialogues (cogens) (Tobin & Roth, 2006) were the primary methodology to learn about student experiences by providing space for reflexivity. Cogens are a forum for
teachers and students to engage in conversations and reflect on teaching and learning experiences together by providing a social space where all participants can connect as equals (Tobin & Roth, 2006). Cogens were held with small groups of two to five students and in one-on-one settings after school. Student researchers used digital cameras to take photographs of their experiences during Field Studies class. Student researchers selected the topics for our dialogues and we used their photographs from the Field Studies class to reflect on events and elicit conversation. Cogens differed from a focus group in that student researchers’ recommendations were used to improve the learning environment in our class and to improve the learning activities for future students. Cogens were digitally recorded and later transcribed to look for themes of identity transformation. In this dissertation I included student researcher’s quotes from transcriptions of oral text. I did not complete a micro-analysis of the transcripts (Roth, 2005). For example, I did not include details of the words spoken as a function of time, or porosity of speech, or body movements. Therefore I took interpretive liberty with student researchers’ quotes by using their words to create a narrative to support themes. Other data sources included students’ Field Studies journals and my field notes. Pre and post surveys were also used to assess student interests in the week long geoscience program described in Chapter 3.

**Authenticity of This Research**

This interpretive research follows the authenticity criteria established by Guba and Lincoln (1989). I use these criteria to establish ontological, educative, catalytic and tactical authenticity. Ontological authenticity is determined as the research accurately captures what is going on in the world and as members develop a more sophisticated understanding of the phenomena being studied. This will be established by listening to members in cogens to determine their understanding of science concepts, and also by determining how their science
identities are transformed. Educative authenticity will be established when student researchers and I, as the teacher researcher, appreciate the viewpoints of people other than ourselves as we change our ontologies, or ways of seeing the world. To ensure educative authenticity is met I will teach student researchers the value of providing everyone a safe place to share their ideas in the cogens so that we can learn from each other. Evidence of catalytic authenticity and tactical authenticity will be reached if the Field Studies curriculum changes as a result of researching with students, or if students enter science fields, or if teachers and students engage in future cogens after this research is completed. It should also be noted that triangulation of data is used in Chapter 3, where students’ science journals, focus group transcripts, and survey responses were paired to support findings. Also, to support authenticity of this research, in Chapter 4, Cynthia served as a co-researcher, and was able to make revisions to any claims or written products from this research.

**Overview of the Chapters**

The first chapter is an introduction to the research where I outline the overall problem, context, theoretical framework, authenticity criteria, and overview of the chapters in this dissertation. In this chapter I describe that this research addresses the importance of connecting science learning to urban students’ lived experiences through place-based science education. I also discuss issues of race and gender that women and women of color face entering STEM careers. These topics are viewed with a sociocultural lens of identity theory to determine students’ science identity transformations as a result of participating in their classes and this research. Cogens are the main methodology for Chapters 2 and 4. Chapter 3 utilizes focus groups and pre and post surveys to research a week long geoscience program. My research is reflexive
in that my own life experiences are included in this dissertation and show evidence of my own transforming identity through this process.

The second chapter describes the Field Studies class at BASE and students’ reflections about the place-based curriculum in settings outside of the traditional science classroom at Prospect Park and BBG. I use a lens of identity and place-based learning to investigate how the Field Studies class transforms students’ science identities. Sense of place is explored in this chapter to describe how individuals can experience the same place, or science lesson, in their own way as they relate it to their lived experiences. I also reflect on my sense of place of the park and garden and my identity as a science teacher. Student researchers used digital cameras during the class and students’ photographs were used in cogens to help explain their experiences. The photographs captured their sense of place of Prospect Park and BBG and students’ descriptions in cogens expressed their science identities. Utilizing students’ photographs led me to the concept of re-seeing (Girod, 2007) the environment. Meaning, one can see the world, such as an aesthetically beautiful nature scene, in different ways, such as through the lens of scientific ideas. Students’ science identities were expressed in different ways through their participation in the Field Studies class and cogens.

The third chapter of this dissertation includes students’ thoughts about participating in a week-long geoscience program in Prospect Park through a collaboration with Brooklyn College and PPA. This chapter was coauthored and underwent peer review for publication in a geoscience education journal. High school students who participated in the program demonstrated that conducting authentic science research projects in their local environment with college faculty and undergraduate students encouraged their science identities. Students indicated they were more likely to pursue geoscience in college after the week-long experience,
that they felt like they were scientists during the program, and that they enjoyed conducting field research projects that provided the Prospect Park Landscape Management department with useful information. During this program students actively participated and contributed to the science community by carrying out their research projects and this legitimate peripheral participation (Lave & Wegner, 1991) empowered students to feel that they could become part of the science community in the future. For example, by entering a science major in college.

The fourth chapter identifies how stereotypes of race and gender are factors affecting participation of women of color in STEM. Through our cogens about the Field Studies class a particular female Caribbean American student emerged as a case study. My student and I held one on one cogens and Cynthia raised the issue of facing a “double-bind” (Ong, 2010) working against her progress in STEM because she is a woman of color. These conversations prompted me to explore critical race theory of whiteness (Frankenberg, 1993) and reflected on how I experienced race relations in my classroom. I describe how I can better address racial issues in my future teaching to support students, especially female students of color, to enter STEM careers and pursue STEM in college.

The fifth and final chapter describes the key claims and implications of my research for teaching and learning, conducting educational research, educational policy, and educational partnerships. I describe how I have observed how teaching and learning are a dialectical relationship in my Field Studies classes. I claim that place-based science education is indeed a method for transforming students’ science identities. My research showed that when particular students participated in authentic science research projects with other scientists in a place-based curriculum, they “felt like scientists”, which engaged their science identities. One way of providing a place-based curriculum was through community collaborations with PPA, BBG, and
Brooklyn College. In addition, the case study exploring stereotypes of race and gender and my understandings of whiteness are summarized. I claim that many teacher education programs will not be able to prepare teachers for all of the potential settings where they will teach, and therefore need to provide new and pre-service teachers with tools for learning from and with their students in diverse settings. For example, I was unprepared to teach in the urban setting at BASE, however utilizing cogens with my students provided a space for my reflection and learning about my student researchers. In Chapter Five I recommend that other teachers use cogens with their students to improve teaching and learning.
CHAPTER 2- TEACHING AND LEARNING IN THE NATURAL WORLD

“A connection to the natural world can still be made in the classroom but it won’t have the same effect as when you’re actually outside and visualizing it first-hand.”

-Kim (October 20, 2011)

Kim is an African American student at the science-themed high school where I am also a teacher-researcher. She engaged in the Field Studies course in 9th grade and met with a small group of students and me to discuss their learning experiences throughout the school year. Kim described her positive experiences in the Field Studies class; how it made science more interesting for her because she could see how science is used to study and understand the natural world. Research supports that an effective and engaging way for students to learn about their natural world is to connect science to everyday life by providing students with science learning experiences that extend outside of the traditional classroom and into the community (Barnett et al, 2006). Brooklyn Academy of Science and the Environment (BASE), an urban high school, strives to provide students with place-based outdoor science learning experiences to enhance student understanding of science and appreciation for the natural world through the Field Studies course. The Field Studies course is required for all entering 9th grade students and activities for the course occur in the school building, the partner botanical garden, an adjacent large urban park, and in the neighborhood surrounding the school.

As a science teacher at BASE I have had the opportunity to work with students and other educators to continually revise the Field Studies curriculum, based on student and teacher feedback, to make the course more engaging for students while providing them a strong science foundation. As a researcher, it is important for me to learn about how this course impacts (or not) their relationship to and perceptions of science, which I refer to as transforming their science
identity. I use the sociocultural lens of identity development to understand how my students experience their course, how it impacts their science identities, and to recognize how my own identity influences how I mediate and interpret my students’ experiences. As a teacher-researcher I have the overarching inquiry of how does the Field Studies class transform students’ science identities? In this chapter I explore how conducting science class in places outside of the traditional classroom, such as Prospect Park and Brooklyn Botanic Garden (BBG) and using a place-based approach, mediates students’ science identities, and potential interest in science. I use Gruenewald’s (2003) lens of critical place-based pedagogy juxtaposed with a lens of identity development to describe students’ Field Studies experiences and the strengths and challenges of the Field Studies course. I share student and teacher reflections of experiences obtained through cogenerative dialogues (cogens) (that I will later describe) between students and myself, and critique to what extent the Field Studies class follows a critical place-based science teaching and learning approach. I use my research findings to discuss how the course can evolve to be more meaningful to students while being responsive to what I learn about students’ science identity development.

**Place-based Environmental Education**

Urban students often face a disconnect between school science and their daily lived experiences, often causing them to not see the importance of science in their lives. This leads to students being unengaged and disinterested in science (Basu & Calabrese Barton, 2007; Brickhouse, 1994). One way to overcome this challenge is to link students to learning about their local environment through environmental education programs that engage students in real-world science experiences in the places that are familiar to them (Boullion & Gomez, 2001; Calabrese Barton & Berchini, 2013; Lim & Calabrese Barton, 2006). Traditionally, environmental
education programs have not generally focused on connecting urban students to their local environments, but instead examine global scale environmental issues, such as climate change and rainforest destruction. This approach does not recognize that it is important for students to connect with and appreciate their local environment before they are asked to think about and offer solutions for global environmental issues (Sobel, 1996). As an alternative to traditional science and environmental programs, environmental educators have proposed that a better approach to teaching and learning uses the local environment as a framework within which students can construct their own learning, guided by teachers.

Place-based education engages students in cross-curricular, or multidisciplinary, methods where knowledge is co-constructed through hands-on, real-world learning experiences. The local community and environment are the contexts for student engagement in language arts, social studies, mathematics and science learning. A place-based teaching and learning approach to environmental education increases students’ understanding of the physical, cultural, historic and socioeconomic meanings of local places (Semken, 2005). Woodhouse and Knapp (2000) note that place-based education: emerges from the particular attributes of a place, is inherently multidisciplinary and experiential, is reflective of an educational philosophy that is wider than “learning to earn”, and connects place with self and community. The concept of curriculum emerging from a particular place is an alternative to current positivistic views and trends in education of testing, global standardization, competitiveness and career training (Gruenewald, 2003; Lieberman & Hoody, 1998; Woodhouse & Knapp, 2000; Sobel, 2005).

According to Sobel (2005):
This approach to education increases academic achievement, helps students develop stronger ties to their community, enhances students’ appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens (p. 7). Place-based education emphasizes and provides the needed context for learning through real experiences, such as local environmental issues, to capture student interest (Loveland, 2003).

There are many documented benefits to teaching science from a place-based perspective. Lieberman and Hoody (1998) conducted a meta-analysis of place-based education at 40 schools nationwide. The schools in the study were well distributed by grade and geography. They combined qualitative and quantitative methods and showed that the place-based approach enabled K-12 students to learn science subjects more effectively than traditional decontextualized programs, enhanced student enthusiasm, and evoked greater appreciation for cultural diversity and deeper understanding of community issues. Gruenewald (2003) challenges educators to incorporate “critical place-based pedagogy” where place-based learning experiences lead to action and change in the community. Freire (1993) explains how being a particular person in a particular community has a spatial, geographical, and contextual dimension. Reflecting on one’s lived experiences includes reflecting on the spaces one inhabits, and acting on one’s situation may include changing one’s relationship to a place (Freire, 1993). Gruenewald (2003) links the spatial dimension of situationality in critical pedagogy, and its focus on social transformation, to place-based education because both deal with contextual, geographical conditions that shape people and the actions people take to shape these conditions. Critical place-based education identifies places as the context for where events are perceived and acted on. Gruenewald’s challenge to educators for teaching and learning for social transformation of communities is worthwhile, however there are challenges to designing place-based science
One of the goals of place-based science teaching and learning is to increase student engagement in the curriculum through connecting science to the local community and showing the relevance of science to students’ lives. It is challenging as an educator to determine what real-life science projects will resonate with students and engage them in critical thinking considering the diverse population of students. My colleagues and I have modified the course to make it more engaging based on discussions about the curriculum with students. Perrone (1994) provides the following guidelines for engaging students in learning: 1) students help define the content and determine questions to research so that activities are “invented” by teachers and students; 2) students need time to wonder and find interesting questions; 3) teachers should encourage students to use different forms of expression to create original products that can be displayed or presented to the public enabling students to be “experts” on the topic; 4) students must sense that their work is not predetermined or fully predictable; and 5) students take action as a result of their study or learning experience. These are components of meaningful learning experiences in general and my colleagues and I have incorporated these guidelines into the Field Studies class.

According to Sobel (1996) environmental place-based education begins with creating a caring attitude towards the familiar (local) area, moves outward to explore the surrounding area, and leads to social action and reinhabitation. Reinhabitation refers to identifying, conserving and creating knowledge that nurtures and protects people and ecosystems (Gruenewald, 2003). This research focuses on the reinhabitation of the natural environment adjacent to the school. When planning and coteaching the environmental science and ecology Field Studies course my
colleagues and I had the overarching goals of providing students with hands-on ecological learning experiences to observe and understand the ecosystems of the local urban park and engage students in authentic science research projects about the local environment. Place-based education recognizes that ecosystems and communities vary around schools therefore schools should design their own programs to take into account the natural ecosystems and sociocultural systems specific to their location, resources, and needs (Lieberman & Hoody, 1998). Because of the demographics of the school, the course is designed to engage traditionally underrepresented students, who may see themselves as outsiders to the field of science (Brickhouse, 1994), in real-world science activities where they have opportunities to develop questions and design investigations of local ecosystems. I will later explain what I learned about the implementation of the Field Studies course from my students and share what I think can be done to improve these kinds of learning experiences for underrepresented students.

**Place and Sense of Place**

Place-based education considers how local places are a context for teaching and learning. Therefore place-based educators must consider that places hold different meanings for individuals based on their lifeworlds (van Eijck & Roth, 2010). Lifeworlds refers to everything in your experience that shapes how you make sense of new experiences (Lim & Barton, 2006). Places are more than just a physical location. According to Semken (2005) space is distinct from place in that space is quantitatively described and universal whereas, place is local and socially constructed, therefore people make places out of space (Brandenburg & Carroll, 1995). There are three components of a place: the physical setting, human activities, and meanings (Relph, 1976). These components are interrelated and can’t exist without the others. As people and places interact, the places develop their own meaning and the people develop a unique sense of the
place (Lim, 2010). Sense of place refers to the meanings of and the attachments to a place held by a person or group (Semken, 2005). It is one’s cognitive, affective, and embodied understandings of a place that are always interacting with the place to give the place meaning (Lim & Calabrese Barton, 2010). Sense of place is influenced by memories, lived experiences, stories told by others about a place, and how these connect to one’s identity (Adams, 2013). Therefore, place becomes a social artifact that is shaped by and shapes people’s activities and identities (Adams, 2013). In this section I will describe how place and sense of place have been described and applied in science education.

Place-based education has become more of a topic of study in recent years (Adams, 2013; Gruenewald, 2003; Smith, 2002; Sobel, 1996) however there is a dearth of research surrounding the role of children’s sense of place in education (Gruenewald, 2003; Lim & Calabrese Barton, 2006). Science curricula in schools is often standardized and therefore students’ sense of place is not a focus in many science classrooms (Gruenewald, 2003). Lim and Calabrese Barton (2006) found that when the teacher facilitated a curriculum that incorporated students’ sense of place in an urban middle school science classroom there were more opportunities for students to make stronger connections between their lifeworlds and science. Leveraging students’ lived experiences with places can be valuable tools for science teaching and learning. As students develop a sense of place they develop insideness, or understanding, of that place (Lim & Calabrese Barton, 2010). Lim and Calabrese Barton (2010) observed that urban children’s insideness of sense of place is exhibited through their environmental understanding (contextualized, critical understanding of a place), environmental competence (how to navigate a place), and diverse, strong affective relationships with a place. Since sense of place influences the ways people observe and interpret natural phenomena, it must also influence how one learns
and experiences science (Semken, 2005). Connecting student learning to place is a way to motivate science learning, empower underrepresented communities and make greater connections between the school curriculum and the students’ lifeworlds (Buxton, 2010; Calabrese Barton & Berchini, 2013). Calabrese Barton and Berchini (2013) propose that focusing on place can help to shift the discourse on urban science education from one of problems to possibilities.

In many science classrooms teachers are often expected to follow a set curriculum. Using students’ relationships with a place may locally differentiate the curriculum and provide more authentic learning experiences for students. Incorporating place into the science curriculum can allow students to bring their own ontologies into school science experiences where students can confirm their existing identities and bring their local ecological knowledge to science learning experiences (Adams et al., 2010). Including place-related pedagogy in school science can dispel the dualistic view students often develop between their lifeworlds and science, as students develop a view of how science connects to their local place. Since places are multidimensional entities whose meaning is formed as people interact with them, individuals will experience places differently and science educators can bring these multiple perspectives into the classroom to better understand a given place. Science educators should also be reflective of their notions of place and how their identities affect their understanding, or sense of a place.

There is a growing body of work that addresses the connection of indigenous or generational residents to place (Lim & Calabrese Barton, 2006; Semken, 2005). However, Adams (2010) questions how students who are not indigenous and don’t have generational connections to their place of schooling may experience place-based education. I found this question valid for many of my students who are first and second generation immigrant students.
This made me wonder if they felt any connection to Brooklyn or had a sense of place that incorporated their new environment. Adams (2013) noted that students who are transnational may have a sense of place in Brooklyn that is linked to cultural ties to other places, based on memories, values and emotions. Therefore, such individuals will experience a sense of multiplace, where they are connected to multiple places at once through history, memories, identity and lived experiences (Adams, 2010). This could also apply to some extent to students and teachers who have moved to the Brooklyn area from other places in United States. I feel a sense of multiplace when in the urban park near the school because the setting reminds me of spending time in nature in Canada. Just as my identity of someone who enjoys and appreciates nature is expressed while in the urban park, students will also recall their experiences and memories from another time and place and incorporate them into their expanding sense of place while maintaining their ethnic identity. Developing a sense of place or multiplace is essential because as we form a connection to a place we will care more about that place and will feel empowered to participate in and assume leadership roles in improving the quality of life in our communities (Tzou, Scalone & Bell, 2010). Place-based science education can be central to an emerging sense of place or multiplace for students and teachers.

For my research, the idea of sense of place has been important because I am interested in how teaching and learning science in settings outside of the traditional classroom, such as determining water quality in the local urban park, or assessing the health of the street trees around the school, or observing leaf structures of tropical plants at the botanical garden, impact students’ science identities. If students’ sense of place in relation to the local park, the community surrounding the school, and the conservatories at the botanical garden, are enacted during these activities students may see science from a different perspective. Although it is not
possible to reach and incorporate all students’ sense of place to the same degree and at the same
time, when educators consider sense of place in their curriculum, they will provide opportunities
for students to make connections between their everyday thinking and scientific thinking.

**Identity**

Similarly to place, identity has recently become a construct used both in research and
practice to describe the relationships between students, especially underrepresented students, and
science. Although there are many ways to define identity, I ascribe to a sociocultural view where
identity is fluid and dependent on interactions with people and places. Individuals have multiple
identities that are continually being transformed as we learn through social life (Adams & Gupta,
2013). We develop our interests and identities through interactions with others and the
environment (Stetsenko, 2008). According to Stetsenko’s (2008) transformative activist stance
theory of learning and human development, activity is central to human development because
through activity we learn collaborative practices of a community, or field of culture, and find our
role within and how we can meaningfully contribute to that community. Identities are associated
with the fields where activities occur and our field-specific identities are mediated by identities
from other fields (Elmesky, Olitsky & Tobin, 2006). As we enact an identity, other people who
interact with us in that field ascribe us characteristics which further reinforce our identity.
Therefore we make meaning of the world and our identities develop through ongoing
interactions with others as we work to achieve both individual and collective goals. Since
identity is fluid our identities will augment as we participate in activities in different fields
(Stetsenko, 2008).

In this research, “science identities” are defined as any aspect of one’s life that enacts
science practices or contributes to one’s desire or interest to pursue scientific endeavors.
Pursuing science means developing knowledges about the physical, biological, and social world through observing, questioning, seeking answers through designing experiments or systematic inquiry, and reflecting on experiences. Here I use the term knowledges, recognizing that there are multiple perspectives or ways of knowing. In this vein, science learning can occur in everyday experiences such as walking in a park, designed settings like a zoo, programs such as after-school science clubs, and through science media for example on TV or the internet (Bell et al., 2009). Bell et al. (2009) outline six strands of science learning through which science identities can develop and be enacted as people interact with science in different places and spaces (see Table 1) both in formal and informal contexts. I have added identity labels for each strand. Although these strands, or identities, are described in a linear fashion, science learning is nonlinear and people can express these different identities during different learning events. However these are useful in thinking about how different types of activities could contribute to positive science identity development.

Table 1

<table>
<thead>
<tr>
<th>Strand</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:</td>
<td>Students experience excitement, interest, and motivation to learn about phenomena in the natural world.</td>
</tr>
<tr>
<td>2:</td>
<td>Students generate, understand, remember and use concepts, explanations, arguments, models, and facts related to science.</td>
</tr>
<tr>
<td>3:</td>
<td>Students manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.</td>
</tr>
<tr>
<td>4:</td>
<td>Students reflect on science as a way of knowing and on their own process of</td>
</tr>
</tbody>
</table>
Reflector learning about the natural world.

<table>
<thead>
<tr>
<th>5: Engaged Sharer</th>
<th>Students participating in science activities and learning practices with others using science language and tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6: Scientist</td>
<td>Students think of themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.</td>
</tr>
</tbody>
</table>

A person who has a strong science identity may have the following characteristics: competence, demonstrates meaningful knowledge and understanding of science content, is motivated to understand the world scientifically, has skills to perform science practices such as using tools and talking fluently, recognizes themselves, and is recognized by others as a “science person” (Carlone, 2007). I have found that these descriptions of science identity have been helpful for me in observing my students and recognizing how they use their strengths to express their science-related identities in the classroom. Some students, who I describe as “Interested” are very curious about observing natural phenomena in lab activities and out in the field. Some students who I would describe as “Explainers” are very focused on the practical aspects of science learning and ask intriguing questions about why what they are learning is important in the real world, while others are more concerned with getting the “right answers” on their lab reports. As students become more comfortable with the science material they may prefer to design their own experiments when given loose guidelines in inquiry labs instead of only reading and following the directions of lab materials exactly as they are written in traditional “cook book” labs. I would describe these students as “Testers”. Some “Testers” are incredibly accurate with measurements, such as determining exact volumes of substances in graduated cylinders,
while others use more approximate measurements and are open-ended in their explorations. Certain students who I describe as “Reflectors” form connections between the science activities and their own lives. I have also observed how students take leadership roles within their lab groups, or during presentations. I would describe these students as “Engaged Sharers”. These students are usually comfortable discussing science material using scientific language. The “Scientist” is the 6th strand of science identity expression where students think of themselves as active participants in the science community. The “Scientist” identity is represented by students who participate in the science research program and are partnered with scientists at the local college to perform authentic research projects. Students demonstrate aspects of their individual science identities in multiple ways and it is my goal as a teacher to provide a variety of opportunities for students to develop and express their different science identities. I also find that it is important for me to create structures that allow these multiple identities to emerge in order to create a collective and collaborative learning experience in the classroom.

Encouraging Science Identities

Many students enter school with at least a slight interest in science—a general curiosity about the world around them. However, many students are not encouraged to pursue science, or do not have opportunities to develop their science interest or engage with others to develop a passion for science (Adams & Gupta, in press). Underrepresented and immigrant students especially lack opportunities for engagement in real-world problems in school science creating a disconnect between school science and students’ lived experiences (Rahm, 2008). These same students are often subjected to the challenges of urban schools such as large class sizes, lack of prepared and licensed STEM teachers, and lack of resources such as lab supplies (Adams, 2007). I have also noticed that underrepresented students face stereotypes labeling them as incapable
and disinterested in science. In my school, we have designed the Field Studies program to counter some of the negative associations with science learning. The Field Studies program provides students with science experiences in the natural world which are intended to connect science learning with students’ lived experiences and in spaces outside of the school building. Because many students who are not successful in classroom-based science have found success in out of school settings (Basu & Calabrese Barton, 2007), we felt that it was important that the Field Studies course take place in a variety of settings, including a local park and botanical garden, to provide students opportunities to experience science from different perspectives and identity building affordances.

Much of the work on identity recognizes that students’ prior knowledge and life experiences should be valued in and considered in science teaching and learning (Basu & Calabrese Barton, 2007; Bouillion & Gomez, 2001). Knowledge is contextual and forms through ongoing interactions between individuals and their world (Stetsenko, 2008). Learning, or acquiring knowledge, is a transformation of identity (Lave, 1996). Therefore, if the knowledge that is learned in the Field Studies class is not relevant to students’ lives or their communities then it might not be valued and not contribute positively to developing a science-related identity. It is important for educators to consider and value that there are multiple ways of knowing about the world; for example students may develop a science-identity around their indigenous or traditional ecological knowledge. Learning how students experience the Field Studies class—the kinds of identities they develop—is valuable for myself as a teacher so that I can plan place-based learning activities that connect students with the places in their lives and support or transform students’ emerging science identities as new experiences are encountered.
Implications for Place-based Education

Place-based education is practiced in a variety of different ways throughout United States (Lieberman & Hoody, 1998; Loveland, 2003; Powers, 2004; Sobel, 2004; Woodhouse & Knapp, 2000). Even within place-based programs, students and teachers have diverse experiences with the same lessons because places in the natural and built world are imbued with varied meanings for different people (van Eijck & Roth, 2010). A challenge of place-based education is that there are as many “places” as there are people because we experience places differently and have unique identities. When teaching from a place-based perspective educators and curriculum planners need to be aware that both students and teachers have prior experiences and knowledge of places, and that places may evoke a variety of memories for different individuals or cultures (Gruenewald, 2003). This allows for connections from a variety of knowledges to be made to the lessons. If science educators can allow space in place-based curricula for students to pursue topics that connect to their sense of place then science learning will become more meaningful and potentially enhance engagement of students’ science identities (Adams, Ibrahim, & Lim, 2010).

Methodology for Understanding Field Studies

As a researcher I recognize that I have reached my inquiries through my personal experiences. I also realize that my students have their own prior experiences that influence their learning in the Field Studies program. Because of the theoretical frameworks that I have used, I believed that a hermeneutic phenomenological (van Manen, 1990) approach was necessary in that it allowed me to reflect on my own stories and juxtapose them with my students’ stories in order to circle events and narratives with meaning. When a researcher is passionate about her work, at some point she will reflect on her own experiences and realize that her experiences have
led her to her research topic. Van Manen (1990) stresses that reflection on lived experiences is always recollective because it is reflection on experience that is already passed or lived through. Reflection on a recent event will include memories and other past experiences as well. Through reflection, thoughts are deepened, thinking is radicalized, and action will eventually flow from this revolutionary thinking (van Manen, 1990). Cogenerative dialogues (cogens), as a methodological approach, allowed space for my students and I to share our experiences in the Field Studies course and co-interpret the events therein.

**Cogenerative Dialogues for Reflection**

Cogens have been used in a variety of educational settings to investigate teaching and learning (Bayne, 2009). Cogens create a new learning environment where the object of inquiry is the classroom environment, or in this case the Field Studies class (Tobin, et al. 2005). Cogens are a structure for students and teachers to share ideas and opinions in a safe environment where participants are listening and receptive and non-judgmental to each other to allow for reflexivity about experiences. Cogens afford a structure for teachers and students to enact a culture of listening and learning from each other about teaching and learning experiences to develop higher quality teaching and learning (Tobin & Roth, 2006). Bayne (2009) explains that the open discussions of cogens create a forum, or field of culture, where the “teacher, students, and others, work together to improve the quality and efficacy of teaching and learning” (p. 517). Bayne (2009) found that using cogens and informal interviewing techniques can support a variety of students and can be especially beneficial in urban science classrooms. Often there are cultural misalignments between students’ and teachers’ knowledges and experiences that can be revealed and discussed during cogens (Bayne, 2009).
My experiences may be different from my students’ experiences growing up in other countries and Brooklyn. For example in a cogen students and I were discussing an activity where we collected macroinvertebrates using nets to scoop out the leaf litter from the bottom of the lake in the park. Students described how they enjoyed physically interacting with the water and using the nets. One of my students shared how this was like their childhood experiences using a seine net to catch fish at the beach. This reminded me of how when I was younger I loved to make “aquariums” at my family’s cottage by using a small net to collect minnows and put them in into a large glass jar with sand, rocks, and sticks to observe for the afternoon. The cogen afforded me the opportunity to share this reflection from my childhood experiences with my students. I was able to acknowledge that even though catching minnows in Canada is different than searching for macroinvertebrates in leaf litter in Brooklyn, or catching sea creatures at the beach, that I too enjoy using nets to catch living things in the water. My knowledge and my students’ knowledge of science and how science is important in our lives may differ, however different ways of knowing about the natural world should be valued. Cogens afford students and teachers a field of culture to generate recognition and respect for multiple ways of knowing.

I invited approximately 30 students in my Field Studies class to attend cogens that were held once a week after school during the 2011-12 school year. Students who participated in the cogens and took digital pictures during the Field Studies class were required to complete assent forms and their parents’ completed consent forms. Students’ were made aware that their participation was completely voluntary; they could join or withdraw from the group at any time and students’ grades in the course were not impacted in any way from attending cogens. Generally cogens included a group of one to four students and myself each week. Occasionally the Field Studies instructor and assistant hired by the park and botanical garden attended the
Cogens. Cogens were used instead of interviews because the cogens afforded a space where, to the extent possible, an equitable space was created where students felt free to share what they were really thinking, either positive or negative, about the class, without feeling like it affected their grade. Cogens were digitally voice recorded and later transcribed to look for themes of science-related identities and to assess place-based science lessons.

As a teacher-researcher I hoped to understand my students’ reactions to the Field Studies activities in order to improve the Field Studies teaching and learning activities for future classes. I also wanted to learn in what ways the Field Studies class mediated students’ science identities. Students who participated in the cogens were considered student researchers because of their contributions to the study. We employed radical listening (Tobin, 2009; Alexakos & Pierwola, 2013) in the cogens as we were learning to view difference as a resource and were not aiming to reach a consensus within the group but were aiming to arrive at a consensus in our understanding of differences. Through giving everyone equal voice and employing radical listening in the cogens, we were afforded agency to learn from each other about how our science identities were forming and transforming through the learning experiences.

**Digital Photography**

I prompted student researchers to take digital photographs during Field Studies of anything that they found interesting, inspirational, or relating to science. Student researchers shared the two digital cameras each week and were not pressured to take photos if they did not feel like participating. I also took photos during the class. Photographs taken during class were used in the cogens to elicit dialogues. Student researchers described and discussed their photographs. These photographs provided a starting point for our discussions and helped us to explain our experiences from our own individual perspectives. Cogens did not always focus on
the photographs but since details of experiences or events are often forgotten, or not noticed, the photographs reminded us of topics to discuss that we may have otherwise overlooked.

Field Studies Program

The fall semester curriculum for Field Studies focuses on four of the ecosystems found within the local 585-acre urban park. The course meets once a week for 2 hours. Biodiversity and biotic and abiotic factors are observed in the aquatic, forest, meadow, and urban ecosystems. In the winter Field Studies is held indoors at the botanical garden where students design and conduct controlled experiments on plant growth and continue their observations in the aquatic, desert, temperate and tropical conservatories. In the spring classes resume outside in the park where students investigate human impacts on particular ecosystems within the park, or urban areas surrounding the park. Students’ spring research projects are presented at the school’s annual Science Fair, where staff from the park, garden, and the community college come to view students’ work.

BASE is unique because of its partnership with Prospect Park Alliance (PPA) and BBG, two institutions with goals of encouraging environmentally aware and scientifically literate students. The support from the partners provide both a Field Studies educator and assistant, and materials for the Field Studies program. The partner organizations also organize internships for students at local agencies, encourage and support students in applying for The Nature Conservancy summer programs, run the school’s gardening club, facilitate harvest lunches, provide the educator for the Young Naturalists after school club, plan special trips and environmental programs for students including organizing the “Dragonfly Camp” trips for BASE students to attend in the summer.
Reflections for Understanding

Learning About Students’ Field Studies Experiences

Prior to my research I became curious about how my students respond to the place-based methods of teaching and learning science in the different settings outside of the traditional classroom such as in the local urban park and botanic garden. I knew that my school had a unique partnership with these institutions so I wanted to see if this influenced how students perceived this class. I engaged in conversations and asked for written feedback with my classes about what they were learning. One day I asked my tenth grade students to write a few of their memories about their 9th grade Field Studies class. One student wrote: “Field Studies made me want to know more about science in nature. I never knew there were so many creatures out there that contribute an enormous amount of energy and help our ecosystem, community and our earth.” Another student wrote: “I remember during the macro invertebrate experiment I volunteered to put the leech in my hand. It was a really good experience.” “I remember the smell of the leaves,” another student wrote. “Field Studies opened a door to my science life,” another tenth grader wrote. Although the responses were mostly positive, several students noted that they did not like going outside in the rain or walking “long” distances. These responses encouraged me to turn to cogens with my students to further understand the role of Field Studies class in the formation and transformation of the science identities of my students and myself.

Transforming Senses of Places

The Field Studies class inspires a spectrum of positive and negative memories and various aspects of students’ identities that are enacted while outside of the traditional classroom. Individuals have a unique sense of place for different locations and the activities conducted there during Field Studies class can potentially expand or transform their sense of place (Lim, 2010).
One of my most memorable learning experiences as a new teacher, although slightly negative, taught me the importance of understanding that students have unique identities and diverse life experiences that determine their own sense of places (Adams, 2012). The first time one of my classes had Field Studies at the park, one of my students was disengaged and hostile towards me during class. Her behavior was quite different at the park than in the classroom and I asked her to stay after class to find out why she was acting differently. The young woman shared that her brother was shot and killed in the park. This was a shock to me. I did not know that she had suffered such a horrible experience. We were unknowingly asking her to relive traumatic memories by bringing her to a place that held other meanings in her life. She continued to attend Field Studies but teachers were more patient and understanding of her behavior and alerted school guidance counselors of the situation. This event caused me to reflect on sense of place and how places hold different meanings for individuals based on their identities and life experiences. As an educator I need to be aware of my students’ different lifeworlds and identities that determine their sense of places.

As my teaching at BASE progressed I became more aware of the value of learning about my students’ backgrounds in order to be more aware of their sense of place in relation to the park and how their science identities are enacted, or not, during Field Studies. Through cogens I learned that holding class at the urban park and botanical garden generally evokes positive memories of outdoor experiences for many students. However, there are exceptions, such as the student described in the vignette above, who was grieving the loss of her brother each time she went to the park. In these dialogues several students have shared that they go to the park for family barbecues in the summer or for special outings with family members, so for many of them the park may evoke feelings or memories of the warmth and safety associated with family.
Students who are newcomers to Brooklyn may connect with the park in ways that remind them of their place of origin. Reflecting in a cogen on a lesson on forest decomposition, a Caribbean-American female student described how seeing the slugs found while exploring under the logs reminded her of the frogs that cover the lawns in Guyana when she goes there to visit her family. Although vastly different organisms, the wetness of the slugs as well as the leopard marked skin made her think of the frogs in her country. Through reflection this student linked new learning experiences in the park to her lifeworld and Caribbean-American identity (Lim & Calabrese Barton, 2006; van Eijck & Roth, 2010).

Another student in the same cogen said that exploring under the logs and being in the forest reminded her of time spent at her Uncle’s house in Upstate New York. Again, this student connected prior experiences in a different location to expand her understanding of activities in the natural world in a new place. Therefore depicting how she learned as her science identity transformed. Many students develop their sense of place as they recall experiences in more remote locations, often of times spent in other countries or places far from Brooklyn when reflecting on their Field Studies experiences. Places link to our identities and remind us of other experiences adding to the meaning and mixing with our current experiences as our identities shift and we develop our new sense of place (Adams, 2010). The cogens provided students a space where students were able to share their learning experience and make connections between learning in the park and life experiences. This made me think about the possible ways that I could create spaces in my curricula and activities to allow these connections to organically happen while students are exploring the park, botanical garden and science concepts in the classroom. I began to observe how the role of our multiple identities are inseparable from our sense of place.
My Sense of Place

As a place-conscious educator, it is important for me to reflect on my own sense of place in order to learn of how my students connect to places. My sense of place interconnects with my identity, emotions and memories. Portions of these factors are activated and recalled when I take students to the large urban park near the school. I enjoy being outside and have memories of relaxing and fun times in the outdoors. Walking outside on a nice day can make me more relaxed. I remember time spent outside during my childhood summers and exploring in the woods making forts with my brothers in Northern Ontario, Canada. These positive associations with exploring nature as a child are part of my science identity. I also like learning about nature and ecology. Sharing my knowledge of these topics with others is enjoyable and gives value to my knowledge. These parts of my identity contribute to why I enjoy taking students outside where I can share my enthusiasm and love of nature in an authentic way.

After seven years of taking students into the field, I have many memories, some good and some bad, of teaching in the park. My identity as a teacher in the park has expanded as I have learned and gained more life experiences in this place with students. For example, my sense of place for different areas of the park includes different meanings for me depending on where I have co-taught different lessons. The Rustic Arbor reminds me of the screams and squeals of excited students when they found macroinvertebrates (such as mayflies, stonefly larva, and caddisflies) in leaf litter pulled from the bottom of the Lullwater. The Nethermead meadow reminds me of students setting up transects to observe the biodiversity of grasses and plants in the turf meadow. When I go to the park without a boisterous class of ninth graders I feel like something is missing. I also find that while I am hiking in Upstate New York, or at my family’s cottage, or in other parks in the city, I am thinking of how I would explain the natural
phenomena I observe to my students or how I could use that place as a science learning
opportunity. My experiences teaching and learning in the park have expanded my sense of place
and transformed my science teacher identity. I see the park and other outdoor places as valuable
teaching resources and refuges.

**Bringing the Field Studies Experience into the School Building**

**Science fair reflections.** Students in the Field Studies class spend the majority of the
spring semester planning and carrying out field observation projects, which they present at the
school’s science fair. In one of the last cogens of the school year we focused our discussion on
the annual science fair. I asked students, “What did you think of the science fair”? Nicholas,
normally a quiet and reserved student who rarely attended cogens called out with more
enthusiasm that I had ever heard him express before: “It was awesome”! I asked why he thought
it was awesome. Nicholas said: “Because we got to show off everything we learned and studied
and researched in the park”. Nicholas is a ninth grade African American student. This was
Nicholas’s first science fair and seemed to be a pivotal event for him in his 9th grade school year.

The Science Fair offers a chance for students to demonstrate what they’ve learned in
Field Studies to a larger audience. Staff from the landscape management department of the local
urban park, educational staff from the botanical garden, cooperating scientists from the local
community college, and teachers from the school who do not teach the Field Studies class serve
as judges. It is also a time for students in other classes, like Geology, Advanced Placement
Biology, Chemistry in the Community, Conceptual Physics, Marine Biology and Science
Research to display their work in science. Student projects are displayed on tri-fold poster boards
and judges circulate through the projects while students present their work. All students receive a
certificate of participation and rubrics are collected and tallied to determine first, second, and third place in each category.

Nicholas’s response that the science fair was “awesome” was very encouraging for me as a science teacher. Although he is a very quiet and shy student, Nicholas’s group determined what each group member was going to explain to the judges during the science fair ahead of time and he felt prepared to participate. Nicholas said that he felt like a scientist while completing the science fair project and presenting because he was sharing his group’s findings. Nicholas transformed his science identity as he was encouraged by his peers beyond his normal “comfort zone” to participate in presenting to the judges. Nicholas described his group’s research question and results:

How does pH affect phytoplankton and zooplankton at three sites in the park? We found a higher pH at the lake and more plankton there. This didn’t support our hypothesis because our hypothesis was that water had to be neutral for there to be plankton.

The cogen was a space where Nicholas could speak about his group’s results and verbally enact his science identity by sharing his understanding of the project. The cogen contributed to his science identity because he openly reflected about his science fair experience. The other students in this cogen said they were surprised to hear Nicholas open up and talk since he was usually so shy. I was also pleasantly surprised to see Nicholas trying on this identity and encouraged him to continue to share with the group. An important aspect of identity development includes being seen as a “kind of person” by others. Other people are important in the development of identities because our identities are shaped by how others see us and the roles we have in a field of culture as we work towards reaching a goal (Stetsenko, 2008). Nicholas was viewed as a quiet student by other students and me and this probably added to his shyness in class. The science fair and
cogens were places for Nicholas to transform and expand his identities by speaking up and moving past his “shy” label. As others start to see Nicholas in a different way it will further encourage his emerging science identity as an “engaged-sharer,” who is excited to speak up and share the results from his science project.

Not all students in the cogen had as positive reactions to the science fair projects. Alexia, a Caribbean American female student said:

I guess we did OK. It was a little nerve-wracking. I didn’t like when one of the judges asked my group member a question and they didn’t know the answer. I tried to answer for him but they were like, ‘No, let him answer.’

Alexia felt that her group could have done better presenting and that their display could have been better. She shared that creating the poster boards felt rushed and that if they had more time their board might have looked nicer. Alexia also said that since she is a strong science student most of her group just expected her to do all of the work and answer all of the judges’ questions during the science fair. Alexia chose to attend Brooklyn Science Academy because it is a science-themed school. For Alexia, being correct is an important part of her identity as a student and this is enacted in her science class. Other students respect her for being a good science student and she identifies as a scientist by saying that she likes science and wants to study science in college. It was difficult for Alexia to work in a group with peers who were not as invested in the project as she was. Alexia’s science identity was encouraged somewhat by the science fair project despite her frustrations with her group. Although Alexia did not have an entirely positive experience with her science fair project I think Alexia exhibits a “scientist” identity in terms of science identities because she describes herself as a science person and other students also see her in this role.
Alexia also expressed her science identity in her digital photographs she decided to take during class. She specifically chose to photograph her peers collecting samples and discovering “new” organisms. The photographs Alexia and others took allowed me to understand their perspectives of the class activities. Figure 1 is of a student in Alexia’s group looking for macroinvertebrates in the urban park’s water system. Figure 2 is of a student’s discovery of a small snail found in the leaf litter.

*Figure 1*. Students used dip nets to collect leaf litter from the bottom of the water source to identify macroinvertebrates.

*Figure 2*. Snail found in the leaf litter of the lake at the urban park.
During the cogens, Alexia presented her photos and reflected on her Field Studies experiences:

At first I didn’t like [the urban park] because of all of the bugs and it makes you feel itchy. Aquatic bugs weren’t as bad. I would have rather been in the water chemistry group because the macroinvertebrates were running away from us…My group liked scooping with the nets and interacting with the water but not necessarily picking through leaves for macroinvertebrates…My group members would find the macroinvertebrates and I would identify them. I tried to make the data as accurate as possible.

Alexia’s science identity is present when she wanted to have accurate data for her project. Her photos and explanations of them indicated this. Other students in her group were not as interested in investing the same level of focus or accuracy with the project and this was frustrating for Alexia. The other teachers and I try to help students determine projects that will interest and inspire them to carefully collect data and feel that their data is important, like Alexia, through completing place-based projects about the local environment. However, even if the projects are about the local area where students live, it is difficult to reach all students’ interests with every project. I value discussing with students what activities they found useful or interesting about the local natural world so that I can replicate and improve these activities with future students.

Alexia’s reflections of her photographs and discussions in cogens enabled her to express her science identity.

As we continued reflecting on the science fair, Kim an African American student, shared her challenges working with her group:

I felt stupid while presenting with my group. One of my group members was saying stupid stuff on purpose…the judges had a fake smile on their face when they looked at our board because we didn’t really have anything on our board…The judges would ask
questions and afterward we would think ‘oh I should have included that’. I had high expectations for my performance. When I went home and thought about it I was like, ‘I should have thought about that’ and that’s why I felt stupid.

Kim participated in science fairs in 6th, 7th, and 8th grade. Kim’s prior experiences with science fairs in middle school may have made her have higher expectations of herself and her performance in the 9th grade science fair. The Field Studies science fair project did afford Kim an opportunity to enact her science identity however she was not proud of her performance during the science fair. Kim was exhibiting a “reflector” science identity in the cogen where she was thinking about how she was learning science and how her performance did not match up with her knowledge or her own expectations.

Overall the science fair projects allowed students the opportunity to enact their science identities by learning about the aquatic ecosystem of the park and presenting what they learned to others. The cogens provided me and the other Field Studies teachers with valuable feedback about how to improve the project for future classes. For example, students requested that we provide more time to prepare their posters. Students also suggested we better explain the rubric so that they could be ready for their presentations. Some students were annoyed that they didn’t get into a group with their first topic of choice and it wasn’t enjoyable to do research on something that they didn’t really want to study. Alexia said she would have rather studied a different topic altogether, such as “researching how people interact with the park, how they treat the park and if they litter or pick plants or what they come to the park to do”. I wouldn’t have considered studying a social science topic in the Field Studies class however this would be an interesting subject to pursue with future classes and makes me think about redefining environmental related studies for urban students in urban contexts. This topic of inquiry also
indicates that Alexia’s sense of place of the park included appreciation for the natural area because she wanted to learn more about human impacts on the park. Students’ suggestions and reactions were shared at the end of the year Field Studies meeting with other teachers and the park and garden education directors.

**Developing a Sense of Place and Appreciating the Beauty of Nature**


One of the goals of the Field Studies class is for students to appreciate the natural world and develop a sense of care or stewardship for the environment. Education should to focus on caring for nature and when students recognize that nature has an intrinsic value this can emerge into an aesthetic relation to nature (Postma, 2009). Kim’s photographs of the landscape throughout the park (Figures 3-7) have an aesthetic quality and depict the beauty of nature. The aesthetic component of science is often disregarded because science education is concerned with standards, conceptual change, and inquiry (Pugh & Girod, 2007). However, “science aesthetics” guides and encourages people to open up to the beauty of nature and allows people to perceive things in meaningful new ways (Pugh & Girod, 2007). Girod (2007) terms this “re-seeing” where deep observation is a means for deepening the aesthetic experience and, in turn, the learning of science. When describing her photographs Kim said “I wanted to take pictures of beautiful things in nature”.
Figure 3. New leaves on a tree in spring. Woodchips are covering the ground because it is a high foot traffic area and soil is compacted preventing the growth of grass.

Figure 4. Lullwater Bridge showing part of the aquatic ecosystem in the park.
Figure 5. Walkway in early spring.

Figure 6. Reflection at the surface of the water showing duckweed growth.
Kim was given the same directions for using the camera as Alexia and other student researchers, which were to take pictures of anything that interests you or reminds you of science. Interestingly, Kim chose to take nature photos of the places where students were conducting science activities and did not take pictures of the actual science activities they were conducting. Kim’s sense of place for the park as an area of natural beauty and serenity are expressed in her photographs. The photos show the natural surroundings of the urban park as an oasis of nature in the middle of the city and express her feelings of appreciation for the natural world. I did not engage in a discussion with Kim about the scientific ideas that are expressed in her photographs. At the time I viewed Kim’s photos as aesthetically pleasing, but did not make the connection between aesthetics and science. We could have used “re-seeing” and analyzed her photos through a scientific lens. “Re-seeing irrevocably transform one’s vision and understanding of the world in aesthetic yet scientifically important and accurate ways” (Girod, 2007, p. 51). Although aesthetics theory in science education is not a focus of this study, Kim’s photographs have inspired me to pursue this topic in the future. I am curious how aesthetics and re-seeing expand
our sense of place and how I can utilize these ideas in my teaching and my everyday experiences as I wonder about the natural world.

Kim described in a cogen that she does not normally go to the park on her own because it is not very close to where she lives and her mother wouldn’t let her go there alone. Other students have also expressed that they do not regularly go to this urban park because it is too far from their homes. Going to the park for Field Studies class opened Kim’s mind to the idea of this natural place where she could experience nature and made her feel more comfortable in these surroundings. I do not encourage students to go to the park alone for safety reasons, but I do encourage them to go there with friends and family outside of Field Studies class time. I think that many students in the Field Studies class developed a sense of place in relation to the park that expanded to include a place for learning science, in whatever ways science learning happened for them. In Kim’s example, her sense of place was expanded to include the beauty of nature that is available in her urban environment. Her experience of the park also confirmed her aesthetic notions of nature—as being a place of beauty and reflection. Kim’s reflections, both through the photos and her description of her photos on the park, demonstrates how students develop an appreciation for this natural space and form a sense of care for the park. I hope that as students get older they appreciate and enjoy the natural landscape and are more likely to protect this natural space and return to the urban park.

**Sense of Place at the Botanical Garden**

Sense of place is not only relationships with places with which people are familiar, but it also includes interactions with places that remind people of the familiar places that are important to them (Adams, 2010). Whenever I enter the tropical conservatory at the botanical garden the warm, moist, musty smelling air fills my lungs. The warmth combined with the smell of
vegetation and the green plants surround me and make me feel like I am transported to a tropical island. I especially like taking students to the tropical conservatory at the botanical garden because many of my students are of Caribbean descent and this place connects with their lifeworlds. While we are outdoors in the urban park I share my knowledge about the temperate forest ecosystem where we live which connects with my lifeworld. With many of my students being from other countries, they are not familiar with the trees and plants found in the temperate forest ecosystem. However, I grew up in this ecosystem and am passionate about nature and am able to explain things to my students. While we are in the tropical conservatory my students who have ties to tropical locations are more knowledgeable about the tropical plants than I am and often have stories about where they have seen these plants before and their uses. Valuing students’ ways of knowing in the Field Studies class may encourage their science identities (Elmesky, Olitsky, & Tobin, 2006). In this setting, they become the teachers and are able to share valuable experience-based knowledge that offers important context to the plants that we observe.

I remember one young man whose face lit up into a huge smile at the sight of the banana tree in the tropical conservatory. He said that seeing the huge banana leaves reminded him of “home”. Although he was in Brooklyn he felt a strong connection to his Caribbean identity through his experience in the tropical conservatory thus adding to his sense of place of the botanical garden. Alexia also shared that she enjoyed the lessons at the botanical garden that were around all of the plants that she knew from the Caribbean. Students develop their sense of multiplace (Adams, 2010) as they merge new experiences in the tropical conservatory with memories of stories and experiences in places with similar climates. The physical surroundings at the botanical garden can inspire these links to students’ identities and add to their sense of
place of the botanical garden. Lim and Calabrese Barton (2006) found science learning is more appealing and relevant to students when it is linked to their sense of place and identities. During Field Studies at the botanical garden students have the opportunity to share knowledge from their lifeworlds that might not be reached or recognized as important knowledge in the traditional science classroom creating the potential for a greater degree of science identity development.

**Is Field Studies Place-based Science Education?**

The theme for the Field Studies science fair projects is how do humans impact the urban park? The park is widely used and hosts more than ten million visitors a year. Topics for human impacts projects have included: soil compaction from people walking on shortcuts between paths, or playing ball in the open fields, thus creating dirt paths where vegetation can’t grow, dumping charcoal near trees altering the soil chemistry, volunteering to monitor the spread of invasive species, such as garlic mustard, and helping landscape management pull out the invasive species, monitoring water quality, or comparing air quality inside the park with air quality along a busy street. In the fall semester students engage in lessons in the different ecosystems of the park and are introduced to field research techniques and issues of concern for the urban ecosystem. The spring science fair projects engage students in the most significant place-based lessons because they choose a topic of inquiry about the park, research it, and then report back to the school community during the science fair about their findings.

I was surprised when I learned that many of my students never went to the urban park outside of the time we spent there for class. Most students did not feel that this urban park was part of their community, although they began to think of the park as part of the school’s community. I was less surprised to learn that students rarely went to the botanical garden outside of class time. Yet, students also came to view the botanical garden as an extension of the school
community. Students were able to connect what they learned in the school community to their local community and make connections between what was familiar to them to the place where they learned to expand their sense of place. Gruenewald (2003) says that educators should follow critical place-based pedagogy where students are critical of their community and work to better the lives of those in their community. Field Studies students report their findings from their science fair projects to the school community and make recommendations to landscape management based on their findings from their projects, however action for improvement is not made. The practicality of this aspect of place based education must be considered and remains a challenging goal for educators and students. If our goal of instilling appreciation and developing a sense of care for the environment are reached through the place-based Field Studies curriculum then students will hopefully become advocates for the park and garden and seek action to improve these parts of their community in the future.

Challenges and Recommendations for the Field Studies Program

The Field Studies program provides a different setting for teaching and learning science and therefore has the potential to transform students’ science identities through the place-based curriculum. This chapter has outlined the Field Studies program and how it reaches students’ science identities so that other educators can replicate components of it in their schools. Powers (2004) found that effective new place-based programs will clearly define goals, inform educators of the resources available, document success of the program and involve teachers and administrators in evaluation of the program. My experiences with Field Studies support the recommendations made by Powers (2004). Teacher, administrator and community buy-in is necessary for a successful program and can be created through providing professional development opportunities for teachers, such as curriculum planning and assessment techniques
for place-based education (Powers, 2004). Providing materials for teachers to use and help “on the ground” will also improve teacher buy-in. Helping teachers find community partners and organizing teachers to work in teams is also recommended. Additionally, facilitating networking between schools, teachers, volunteers, administrators and program staff will support partnerships and collaborations. Continuing to follow these recommendations will help the Field Studies class continue to be a success at BASE.

Designing curricula that are relevant to students’ lives is a challenge for Field Studies educators. One of the goals of the Field Studies class is to follow a place-based science curriculum so students understand how science is important in their lives and communities. This is difficult for me because my lifeworld is different from the lifeworlds of my students. In order to address this challenge I discuss the curriculum with students in cogens and share this information with my co-teachers so that we can modify the lessons for future classes. Through revising the curriculum we are trying to make it more engaging and following more of a place-based model. For example, students from one class said that they did not feel comfortable doing the street trees lesson in the neighborhood that they were unfamiliar with. For the next year, the other teachers and I changed the location of the lesson to be on the streets closer to the school. This made the lesson more relevant to students’ lives because they were identifying and assessing the health of trees that they see coming and going from school. It may not be possible to address the interests of all of my students in each lesson or project, and what is interesting to one student may not be of interest to another. However by listening to my students and learning from them in cogens I can try to reach as many students as possible.

Another way to reach student interests was to provide students with the opportunity to choose their topics, within certain parameters, for their Science Fair projects. Perrone (1994)
recommends one way to engage students in learning is to have them form their own research questions. Students suggested that they wanted their research results to be more meaningful. I modified the curriculum based on student suggestions. For example, the following school year science fair projects for my class incorporated place-based education as students studied the spread of an invasive species called Garlic Mustard in various regions of the park. I also had to modify the science fair projects because had more limited resources available and only one Field Studies assistant due to budget cuts to the education department at the urban park. The director of the landscape management department for the park met with my class to explain how to identify the plant and introduced the problem of the spread of this plant in the park. Garlic Mustard can grow in poor soil conditions and spreads quickly, choking out other plants native to the area. Students were asked to determine the population density of the plant in four different locations using a protocol which required setting up plots and counting plants and recording specific GPS coordinates. Students made recommendations to the landscape management department of where Garlic Mustard growth was most prevalent so volunteers could be organized to pull the plants.

Although I selected the overall topic of studying Garlic Mustard for students’ projects, students developed additional research questions within the topic. For example: where is Garlic Mustard most prevalent, or which location has the most established Garlic Mustard population? This place-based project was in line with Perrone’s (1994) recommendations that students will be engaged in their learning if they develop their own research questions and if they feel their topics are important. Surveying Garlic Mustard in the urban park was relevant to the health of the forest ecosystem in the urban park and introduced the concept of invasive species as a human impact while incorporating field research skills such as: plant identification, plotting, and
mapping. My interest in the topic made me invested in helping students get the best results possible. Some students had more interest in the project because they felt their results were meaningful since they had to report their findings to the landscape management department during the Science Fair. It is an ongoing challenge to connect students’ interests and lives with the science curriculum but by incorporating a place-based curriculum where students are learning about a place close to home, and keeping an open dialogue with students, I hope to demonstrate the importance of science in our daily lives.

BASE is fortunate to benefit from the resources and support provided by the partner institutions. The Field Studies program would be much more difficult for teachers to implement without the support of Prospect Park Alliance and Brooklyn Botanical Garden. Schools and teachers who do not have the support of such organizations should not be discouraged from offering courses like Field Studies. Having extra teaching support and supervision in the field is incredibly valuable and legally necessary in most places for taking students on school trips. I recommend that teachers who are planning science lessons outdoors seek out committed chaperones who will help to actively engage students, whether parents, other teachers, school aides, or volunteers from the community. Many of the materials we used, such as water quality testing kits, are easily transported in backpacks and students could carry them from the school into the field. Having these materials organized ahead of time and providing clear instructions and having students in cooperative learning groups with specific roles saves a lot of confusion while on location. Teachers may also seek out partner organizations in the community that may be able to assist, or teachers can apply for funding for materials or additional teaching staff through grants. BASE continues to benefit from the partner organizations and the cooperation of the school’s administration to make the Field Studies program possible.
Lessons Learned Through Field Studies

“The Earth is more to be admired than to be used” (Henry David Thoreau).

The Field Studies program at BASE attempts to connect students with their local environment and the natural world as they learn methods for studying ecological concepts about the ecosystems of the local urban park. Students also participate in science learning at the botanical garden and in the neighborhood surrounding the school. Holding science class in these different contexts outside of the school building engages students’ science identities in different ways. Photographs and cogens were useful methods for student reflection about the Field Studies class and helped to address one of my original inquiries with this research which was: how are students’ science identities influenced by holding science class outside of the traditional classroom? Photographs of the activities and discoveries during class added details to Alexia’s reflections and helped set the scene for the events she was describing. Through her reflections in cogens and her science fair project Alexia demonstrated that in Field Studies class she learned about ecological field research in the local park and engaged her science identity. Connecting science teaching and learning to places close to students’ homes can instill more appreciation for the natural world and build on students’ sense of place for the local area. Kim expressed her appreciation for nature through photographs of the natural beauty in the park. This chapter opens with a quote from Kim about how being out in nature fosters a better connection with nature than just learning about it in the classroom. I hope that through the Field Studies experiences my students expand their science identities to incorporate the importance of ecological concepts as they develop a sense of appreciation for nature.
CHAPTER 3- ENGAGING UNDERREPRESENTED HIGH SCHOOL STUDENTS IN AN URBAN ENVIRONMENTAL AND GEO SCIENCE PLACE-BASED CURRICULUM ¹

Encouraging Interest in Science

There is an ongoing effort in the United States to encourage and support students from underrepresented groups in pursuit of the STEM fields especially in the physical sciences (National Science Foundation, 2006). Science education research points to the disconnect between school science and students’ day-to-day lived experiences as a reason for a lack of interest in science (Lemke 2001, Roth and Tobin, 2007). Underrepresented and immigrant students are often at greater risk of losing interest in science as there is the added cultural and linguistic disconnect between school, school science and their lifeworlds (Rahm 2007; Basu and Barton, 2007). Even after controlling for academic achievement and student background, the most predictive factor in students dropping out of high school and ultimately out of the STEM pipeline is the lack of student engagement with real world problems and solutions in the coursework being taught in their high schools (Connell et al., 1995; Rumberger, 2004). Edelson et al. (2006) note that for learning experiences to lead to usable knowledge, students must recognize the usefulness of the knowledge or skill in their lives and future goals. In our work designing STEM education programs and courses, we have learned that underrepresented students are driven by goals that focus on their home, family, community and career, an observation that is also supported by current research (Adams, 2012; Powell et al., 2009).

The “Preparing the Next Generation of STEM Innovators” report recommends that all students should have opportunities to “experience inquiry-based learning, peer collaboration, 

¹ An earlier version of this chapter was published in: DeFelice, A., Adams, J. D., Branco, B., & Pieroni, P. (2013). Engaging underrepresented high school students in an urban environmental and geoscience place-based curriculum. Journal of Geoscience Education. Vol. 62, No. 1, pp. 49-60. doi: http://dx.doi.org/10.5408/12-400.1
open-ended, real-world problem solving, hands-on training, and interactions with practicing scientists and other experts” (National Science Board 2010, p. 16). Environmental education is more likely to be effective if placed in the context of the community as it leverages that with which people are familiar and care about (Andrews, 2009). This chapter describes a project and corresponding assessment with the central goal of engaging underrepresented youth in environmental science studies. It begins with a brief presentation of the design process of the project, discuss the results of the implementation, and conclude with implications for place-based environmental science for underrepresented youth.

**Pedagogy of Place**

Place-based education, as a “community-based effort to reconnect the process of education, enculturation, and human development to the well-being of community life” (Gruenewald and Smith 2008, p.xvi), is an ideal pedagogical tool to engage students in the deep learning of science. This is more critical for underrepresented and immigrant families that are unfamiliar with American education norms, where schools are commonly perceived as being "in communities, but not of the communities" (Bouillion and Gomez, 2001, p. 878). Place-based education affords the attenuation of borders between the schools and community. In addition, as standardized education is becoming more of the norm, a pedagogy of place-based education allows for the localization of standards; that is, a means of making standards and assessments more meaningful and place-relevant for students. For example, the New York State Earth Science Regents curriculum outlines learning standards for the whole state although it has geologically and ecologically distinct regions. Place-based education encourages educators to look to local resources to engage students in learning about geoscience content and concepts as relevant to the place where they live and go to school.
Sociocultural View of Learning

Recent science education research has pointed to identity development as an indicator of positive performance in STEM-related pursuits (Adams and Gupta, 2010; Luehmann, 2009; Tobin, 2007; Olitsky, 2007; Rahm, 2007). While there are numerous theoretical frameworks that describe identity-development, the one that guided our project aligns with an “identity-in-participation” framework that recognizes that identity development is shaped in activity and in relation to others (Adams and Gupta, 2010; Hull and Greeno, 2006). Stetsenko (2008) extends this to the process of learning by describing learning as “profoundly social and collaborative,” not only in respect to the people engaged in social activity, but also in respect to the places that the activity happens (Adams and Gupta, 2013). Stetsenko (2008) cites, “learning then appears as the pathways to creating one’s identity by finding one’s place amongst other people and, ultimately finding a way to contribute to the continuous flow of social practices.” Thus, we believe that developing opportunities that allow youth to contribute to the “social practices” of science while learning the culture of scientific research provides the space for them to build identities around science with the corresponding skills and dispositions that could contribute to successful pursuit of the discipline.

Cultural lenses shape students' perceptions of new knowledge and skills; if a lesson is perceived by a student as empowering them to shape their life, community, and world, they are more likely to accept the information and welcome related information and skills (Bouillion & Gomez, 2001). In their study of urban underrepresented youth, Basu and Barton (2007) noted that students considered science useful when it could be applied to everyday priorities, made their lives easier, increased control of their lives, solved personal or social problems, or validated their leisure or pop-culture activities such as sport or music. Furthermore, Basu and Barton
concluded that underrepresented youth developed sustained interest in science when it connected to their vision of their future, and was in-line with their perception of the purpose of science. In this program, we present a model where student input was central to the design of the science-learning activities under the premise that incorporating their interests would lead to increased engagement and motivation to participate which, in turn would influence their science identity development.

This project, funded by a National Science Foundation (NSF) Opportunities for Enhancing Diversity in the Geosciences (OEDG) planning grant had the overarching goal of identifying program elements that would engage and motivate underrepresented students to study environmental science. The focus of the project was Prospect Park, a 585-acre park located in the center of Brooklyn, NY. This Olmstead and Vaux designed park is the site of family outings and recreational activities for many of the participating students, including sports practice, music concerts and cultural events. The overarching question that motivated this project was: in what ways does collaborative community planning and engagement in field work in a local park influence science identity and increase youth engagement in science in underrepresented students? We predicted that outdoor field work in the local park would enhance student science identity and increase youth engagement in science. The OEDG planning grant allowed us to assess the immediate impact of the project described below on student science identity and engagement, but lasting impacts were not assessed.

It is important to note that the project involved students from the Brooklyn Academy of Science and Environment (BASE HS), a New York City public school that has close, formal ties with Prospect Park and the Brooklyn Botanic Garden. In addition, many of the students live near the park, which is one of the few natural environments they have experience with in their highly
urbanized community. With sense of place defined as a “living ecological relationship between a person and a place” (Lim and Barton, 2006) we know that most of the students have a relationship with the park outside of school and therefore we describe this project as place-based versus a disconnected outdoor experience. Furthermore, since identity development is central to our understanding of underrepresented students’ relationships to science, our identity-in-participation framework allows us to situate place as an active agent in the students’ science activity and recognize the role of place in shaping identities (Adams, 2013). Thus, the activity in the park, that is a familiar place to students in the study, takes on a different meaning than similar activities in the classroom or in another unfamiliar park.

**Designing Place-based Learning Experiences**

A one-week research experience program was collaboratively designed by a committee of teachers and two high school seniors from the Brooklyn Academy of Science and the Environment (BASE), faculty from Brooklyn College and staff from the Prospect Park Alliance, including natural resource or landscape managers. The participation of the landscape managers ensured that the research performed by the students was relevant to current issues in the park. The team met two times for day-long planning meetings on the weekends in the spring and fall to discuss the goals of the project and how to integrate the natural resource management needs of the park. The BASE students worked with their teachers to survey their peers and identify an initial list of topics and activities that would interest them in environmental science. They then brought their findings into the committee meetings to be incorporated into the program. The collaborating students’ survey of their peers found that they were interested in studying the “creepy crawly nature of living things”. As such, research topics were intentionally selected to
include an authentic link between biology and the geosciences, with an emphasis on the effects of the physical environment on organisms.

The program was offered during New York City Public School system’s Spring Break in April 2010. It was a five-day program that met for six hours a day. Students were recruited from BASE through a competitive application process. After careful review of applications by a committee of two Brooklyn College faculty and two BASE teachers, 22 students were selected from over 50 applicants. Students were selected based on teacher recommendations and a personal statement of interest. We focused on students interested in college and the STEM disciplines, and who were likely to commit to fully participate during the week-long experience. Thus, a limitation of our findings is that this was not a random sample of students. However, the students that were selected were typical of the socioeconomic and racial status of all students in the school, and all were from groups underrepresented in the geosciences. We intentionally selected students to provide a balance across grades 9 through 12. Participants included 16 girls and 6 boys, comprising five ninth graders, seven tenth graders, six eleventh graders and four twelfth graders. The majority (77%) identified as Black, Caribbean or African-American, with 14% identifying as Latino and 9% as “other.” Sixty-three % identified English as their first language, with Creole/Kreyól (14%), Spanish (9%) and “other” (14%) also represented. Students were told that a part of the project was learning about their interests and engagement in studying place-based environmental science. They were placed in the role of student-researchers and received a stipend for their participation in the program.

Survey items served as the primary data source for evaluating the project outcomes and objectives with journal entries used as secondary data sources. The survey was a nine-point

---

2 I address my stance on positivism in Chapter 5.
Likert-scale pre- and post-survey (Appendix A). Pre-surveys were distributed with information packets and parental permission slips and returned before the first day of the program. Post-surveys were administered on the final day of the program. The means of the pre- and post-survey results for each question were compared using descriptive statistics and paired t-tests. In this case Likert-scale scores were treated as interval data which qualifies for a parametric technique such as a t-test (Fraenkel et al., 2012; Norman, 2010). An assumption was made that the data are interval. The t-test for correlated means, which is a parametric test of statistical significance, was used to determine whether there was a statistically significant difference between the means of the pre and post surveys. Additional data sources included field journals and focus groups, though focus group data are not presented here. Students were provided with field journals to record their notes, methods and procedures, field and lab observations, and their responses to the reflective journaling questions posed by the education researchers. Reflective journaling topics were posed daily and included questions such as:

- What did you find most interesting about your experiences today? What did you most /least enjoy about today?

- Do you enjoy working in a team of researchers, why or why not?

- When did you feel like a scientist today?

Students’ responses to the reflective journaling questions were coded for themes such as: science identity, outdoor science learning, and working with college students and faculty. Students also participated in digitally-recorded daily focus groups where they reflected on their experiences and findings. Additional data sources included student PowerPoint presentations, the researchers’
field notes, and videotapes of students engaged in research activities in the park for later analysis.

**Research Experience Program**

Two issues of concern in the park were posed to students on the first day of the program by the representatives from the park’s Landscape Management office: (1) soil compaction from people walking on the grass and forming their own paths, called desire lines, was presented to students, and (2) seasonal algae blooms in Prospect Park Lake. Students and the college faculty worked together to develop the following three research questions based on these two issues. What is the effect of soil compaction on earthworm abundance? Are the lake sediments a source of phosphorus, which might be helping to fuel the algae and cyanobacteria blooms? Is oxygen consumption by the lake sediments an important driver of anoxia? Students were asked to develop a plan to research these issues, perform the research activities, and make recommendations for management and/or further research based on their findings. Landscape managers requested that students present their findings at the end of the week. The science faculty member framed the inquiry as students being a part of a research project team in which he is the lead scientist. He described the structure of a research lab and the role that the students would play within the lab structure. Student researchers worked in teams, with each team led by an undergraduate student. Once the questions were posed, they followed a guided inquiry approach, where possible methods were suggested and demonstrated by the lead scientist. The themes for student research and measurements are briefly discussed below. Table 1 summarizes the students’ research activities.
Soil Compaction

The first research theme was the human impacts on soil properties and earthworm abundance. Soil compaction from foot traffic is a continuous problem for Landscape Management because there are so many people who use the park each year and they often ignore marked paths and access barriers such as fences. Earthworms play an important role of decomposition in the soil, mixing soil layers and aerating the soil. The number of earthworms present would be an indication of the level of soil compaction. Students were asked to collect data on differences in soil compaction and earthworm abundance between impacted and non-impacted areas in the park.

Algae Blooms

The second theme was the drivers of algae blooms in Prospect Park Lake. The lake suffers from advanced eutrophication that results in intense algae and cyanobacteria blooms every year. As a consequence the lake experiences prolonged periods of bottom anoxia that can negatively impact the aquatic ecosystem. The cyanobacteria blooms are potentially toxic and can impact the health of park visitors and their pets. Students were asked to investigate if phosphorus fluxes from the lake sediments might be helping to fuel the algae and cyanobacteria blooms, and if oxygen consumption by the lake sediments was an important driver of anoxia. The results could assist the landscape managers in taking corrective action for the eutrophication problem.

Research Teams

A hierarchical research team structure was implemented to add authenticity to the research experience. The students were organized into four teams of research assistants with twelfth grade students serving as team leaders. An undergraduate Earth and Environmental
Science major from Brooklyn College was placed with each team to serve as both a junior scientist and near-peer mentor. Two science faculty from Brooklyn College assumed the roles of lead scientist and senior scientist to oversee the activities of the research teams. The undergraduate students included an Afro-Caribbean female and a Hispanic female, a Hispanic male and a white male. The lead scientist was a Caucasian male and the senior scientist was a Caucasian female.

The student research teams each completed several complex tasks and experiments related to the major themes (Table 2). They worked closely with the faculty members and undergraduate students to complete measurements and observations using sound scientific practices. Students were each provided with a Jim-Gem ® field notebook to document their research activities. Each day the teams met with the lead scientist to discuss their progress, results, and analysis in context of the research questions. Each team worked with their near-peer mentors to construct a PowerPoint presentation of their findings, which was presented to representatives from the Landscape Management department (Table 3). The presentations also included student recommendations for management actions and future research that were based on their findings.

Table 2:

Student Research Activities for the Week-Long Research Experience

<table>
<thead>
<tr>
<th>Research themes:</th>
<th>Measurements and experiments conducted by student teams to address theme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme 1:</td>
<td>Soil horizons-Students collected</td>
</tr>
<tr>
<td>Human impacts on</td>
<td></td>
</tr>
<tr>
<td>Theme 1:</td>
<td>Theme 2:</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>soil properties and earthworm abundance.</strong></td>
<td><strong>The relationship between lake sediments, algae and anoxia.</strong></td>
</tr>
<tr>
<td>soil samples using a soil borer and compared composition of soil in forested area of park with compacted soil areas.</td>
<td>Water quality testing- Dissolved oxygen, pH, temperature and turbidity were measured in the lake using handheld multiparameter meters.</td>
</tr>
<tr>
<td>the rate of water infiltration as a measure of soil compaction.</td>
<td>Bottom sediment oxygen demand and phosphorous levels- Students used a boat and grab sampler to collect lake sediment. Students measured oxygen consumption by Winkler titrations and phosphorus changes using colorimetric kits.</td>
</tr>
<tr>
<td>solution to drive earthworms to the surface within a quadrat where they could be counted and described.</td>
<td>Plankton tow- Students collected plankton samples using a plankton net and observed and identified zooplankton and phytoplankton using microscopes.</td>
</tr>
</tbody>
</table>
Table 3:

Student Findings and Recommendations

<table>
<thead>
<tr>
<th>Research theme</th>
<th>Major findings presented to landscape management</th>
<th>Recommendations presented to landscape management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human impacts on soil properties and earthworm abundance</td>
<td>- Water infiltration rates are slower in more compact soil.</td>
<td>- Increase signage in the park about the importance of staying on marked paths to avoid compaction.</td>
</tr>
<tr>
<td></td>
<td>- Water infiltration rates are inaccurate when soil is already saturated from rain.</td>
<td>- Fence off areas of high compaction for periods of time to allow regrowth of plants.</td>
</tr>
<tr>
<td></td>
<td>- Some areas of the park have more compact soil than others.</td>
<td>- Continued surveying of earthworm abundance in various locations throughout the park is necessary to monitor this important population in the ecosystem.</td>
</tr>
<tr>
<td></td>
<td>- Soil horizons show differences depending on location. There is thinner top layer of soil in areas of compaction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- There is a relationship between the soil compaction and the type and size of</td>
<td></td>
</tr>
</tbody>
</table>
Earthworms are important for soil aeration. Lower earthworm abundances were found in more compact soils.

The relationship between lake sediments, algae and anoxia

- There are higher than normal levels of phosphorous in the lake sediments.
- There is low oxygen demand in the lake sediments indicating that there is not much organic matter in the sediments.
- A variety of plankton are found in Prospect Park Lake.

- Dredge portions of the lake to remove excessive phosphorous deposits and continue monitoring nutrient levels.
- Take plankton samples at different times of year and different times of day for a more complete understanding of types of plankton present in the lake.

**Pairing Survey Data and Student Journals**

Here we present and discuss the results from three survey questions that showed statistically significant positive changes from the pre- to post-survey iterations. These results are of particular interest since they relate to the learning and engagement outcomes and objectives of the project. The limitations of these results must be considered, since this was not a random
sample or a norm referenced survey. The post surveys were conducted after the week long experience to determine immediate impacts of the program. The lasting impacts from the program were not measured as it was beyond the scope of the OEDG Planning grant. The preliminary findings from the survey data were paired with student journal reflections. This triangulation of data allowed us to assess the impact of our place-based curriculum on students’ science identities and student engagement in science.

**Being a Scientist: Identity in Participation**

There was a statistically significant increase from the pre to post survey for the construct “I consider myself a scientist” (6.9 ± 1.5 to 7.6 ± 1.2; tcalc= 3.26, df= 21, a=0.05). Assumptions were not verified because the pre and post surveys were from the same students. We assumed that students would answer to the same degree of accuracy both times they took the survey. This result indicates that students were more likely to self-identify as scientists following the week-long research experience.

Student journal responses were analyzed to look for instances where students felt like scientists during the week-long program. Each day of the program students wrote written reflections in their journals to the question “When did I feel like a scientist today?” The following examples showed up in multiple journal entries to this question, they felt like scientists when: they were touching equipment, worms, and soil, completing the chemical testing for dissolved oxygen, mixing the mustard solution for the worm experiment, going on the boat to collect samples, using microscopes to view plankton, discussing in groups, sharing data, and presenting their findings. One student noted, “I felt like a scientist today when I learned more about titration. Also, I felt like a scientist when I was note-taking and collecting data about the
different experiments and projects.” Students felt agency over being able to take their own notes and do independent data collection. This enabled them to assume the identity of a scientist during the week-long program and therefore “feel” like a scientist and experience the embodied notion of participation in the culture of practicing science.

Students also expressed that they enjoyed being with people where the knowledge of science was appreciated. Several students shared that when they learned methods and were able to show other research teams how to perform the procedure they felt like experts:

I felt like a scientist when I was directing the show in Prospect Park today. I was like an expert in the worm sampling test so I was showing the other group what was supposed to be done.

This authentic science context enabled this student to assume the role of an “expert” and experience science leadership by explaining research procedures to others.

Students also cited presenting their findings to an audience of peers and Landscape Management as a “feel like a scientist” moment. One student describes this experience:

While I was presenting my data I felt a little nervous at first. However, as I got more into it I realized that I’ve done research in Prospect Park and now I’m presenting my data and my findings. I felt more confident and like a scientist who is sharing their findings.

This student had the realization that she did the research and was therefore knowledgeable about the work she was presenting. This was a source of empowerment and put them in the role of a professional scientist in this instance. This same student also described how presenting the research was a valuable part of the experience: “I felt like a scientist today when I presented my
data, it made me feel like the research was more important”. Representatives from Landscape Management reported they were impressed with students’ presentations and students’ findings confirmed some of the ongoing research on the issues in the park. This supports existing literature that describes students as being more engaged in science learning when they recognize the usefulness of the knowledge or skill (Edelson et al., 2006). Students were not merely doing science activities but were engaged in science by forming questions, searching for answers to their questions, participating as a member of a research team, and presenting their findings.

**Connecting Students to the Science Community**

For the survey construct, “I think high school students are able to work with college professors and researchers on science projects,” there was a significant increase from the pre to post surveys ($7.7 \pm 1.5$ to $8.5 \pm 0.7$; $t_{calc}= 2.61$, $df= 21$, $a=0.05$). Students participated in the role of research scientists alongside undergraduate students and college professors on teams supporting that this experience would increase student engagement in science. The social interactions that occurred in this collaborative, place-based setting allowed students to view themselves as authentic members of a science research team. This was confirmed in the responses to the corresponding journal reflection question, “What did you think of working with undergraduates and scientists from the local college?” Student journal responses repeatedly included positive reactions to working as a team with college faculty and students because undergraduate students were knowledgeable about the procedures and explained what college was like. One student expressed in their journal:
Working with the undergraduates is pretty cool. Being able to talk to them and to listen to them talk about their hands-on experiences is awesome. It’s good to know that these students get to travel and investigate about the Earth.

This same student also wrote, “Collaborating with professors and students was really cool because they educate you more about what it’s like being a college student in terms of maturity”. Another student responded in their journal “I felt like I was one step closer to college. It was fun to hear the undergrads’ situations and stories…I felt good, like I was really in college doing research.” Working on collaborative teams enabled students to contribute to the practices of the science community. The Brooklyn College Earth and Environmental Science faculty member framed the experience with him as the lead scientist with the students working in teams on his project, similar to what would happen in a college research setting. Throughout the week, students always had access to the lead scientist and were able to ask him questions or discuss their experiences at any time. Students were immersed in the social experience of being scientists and were able to make meaningful contributions to the research process.

**Place-Based Science Education**

Finally, for the construct, “I would rather learn about science in the park than in the classroom,” there was also a significant increase from the pre- to post-survey (7.6 ±1.4 to 8.5 ± 0.8; tcalc= 3.35, df= 21, a= 0.05). This result suggests that students’ preference for learning outdoors increased as a result of participating in the program, despite or perhaps because of, the rigorous and demanding nature of the activity. This supports the body of knowledge suggesting that outdoor science education may raise students’ levels of enthusiasm for learning science.
(Smith, 2007) and suggests that students’ engagement in science would increase as a result of the program.

The corresponding journal question was, “What did you like and dislike about collecting data in the local urban park?” to which many of the students responded that they enjoyed collecting their own samples outside:

In general, I liked collecting data outside of Prospect Park because it gives me hands-on experience and I really get to connect with the environment. It’s better than people bringing data to you and you have to give the results.

This collaborative, place-based research setting allowed students to experience hands-on science and a certain degree of agency in collecting their own data. One student described it as feeling “free” and another student described the experience “I liked being outdoors going to different sites and not just seeing them as a place to look at but as a place to research and be able to get potentially important data from them.” Several students noted having a better understanding of the data because they collected it themselves, for example: “When you collect data yourself it makes things much more understandable and that is what this research experience did for me”.

However, there were aspects of being outdoors that students disliked. For example, most students disliked working outside in the rain and some disliked the long walks. In spite of this, the students stayed engaged throughout the week, and motivated to get the data needed to address the research questions about the issues in the park. This supports the literature that shows students are more interested in science when they can see the usefulness of the topic to their lives and community (Basu & Barton, 2007).
We chose to discuss the three constructs above because they were found to be statistically significant and best aligned with our overarching questions. The results point to the positive impacts of place-based, authentic science-learning experiences for underrepresented students. They are not only opportunities for students to engage in hands-on science learning, but also the chance for students to engage in social interactions with peers, near-peers and mentors in a scientific context; in other words, the opportunity for students to learn and engage in the culture of science in a familiar out-of-school context. This provides positive science identity-building experiences for students and a chance for them to get an initial idea about what it would be like to study science at the college level.

Self-identification as Scientists

We assessed how students’ science identities were immediately influenced through participation in a week-long geoscience research experience with college students and faculty. The key findings support that the program would enhance students’ science identities and increase youth engagement in science. Results show that students’ science identities were positively impacted and the outdoor place-based experience influenced their ideas of what it is like to be a scientist. Students reported many instances of “feeling like a scientist” throughout their week-long experience and felt that they were valuable contributing members of the scientific community.

The second project outcome we evaluated was how a place-based, environmental geoscience curriculum could increase the engagement of underrepresented urban youth in science. The guided inquiry experience was planned specifically for Prospect Park to address geoscience and environmental issues using input from other students, landscape managers, and
college faculty. Since most students were familiar with the park, they were able to use their experiential knowledge to help address the scientific research questions, such as knowing areas of high foot traffic and having seen differences in the color of the lake throughout the year. Major findings here support the efforts of place-based science education to engage students in meaningful science research in their community park. Students positively responded to collecting their own data in the field. Students felt and acted like experts, demonstrating an embodiment of practicing science, supporting that this outdoor learning experience would enhance development of science-related identities and increase student engagement in science. It is clear from this project that students were more engaged in geoscience learning when researching and providing solutions for an actual problem in Prospect Park.

Several limitations to the survey and student group should be noted. First, the Likert-scale survey was a nine-point scale and although statistically significant, the difference in the pre and post surveys is small. Second, the long-term effects of the program on students’ science identities and interests were not measured. Third, this evaluation did not focus on individual students and their changes, but on the collective group of students. Further research could look at changes in students who had a major shift in their survey responses. Fourth, the students who were recruited to participate in the study already had science identities, as the pre-survey indicated. While it would have been more transformative to recruit and note the change in students who had little to no science identity, we were encouraged by the positive trend in our results. Despite the limitations the preliminary findings are encouraging for science teaching and learning. Place-based projects, like the one described here, provide opportunities for high school students to connect with university science communities who are engaged in local environmental research. Students, who are given the opportunity to interact meaningfully with undergraduate
and faculty science researchers, and to contribute to authentic science communities of practice, may experience positive enhancement of their self-identification as scientists. In agreement with the NSB (2010) recommendations, this project provided the opportunities that would prepare students to enter the STEM fields. Students responded positively to doing hands-on research with peers and scientists to solve a real and visible problem in their local park.

As a science-themed high school, students at BASE High School are encouraged to participate in other science programs. Some of these include the Young Naturalists extracurricular club for ninth graders where they study the ecology of Prospect Park. Students could conduct conservation projects during a summer month in the Nature Conservancy’s LEAF Internship or work in the Garden Apprentice Program at Brooklyn Botanic Garden where they prepare to be educators at the garden for the general public. Students have opportunities to be paired with mentors and participate in scientific research at the American Museum of Natural History and the Science Research class at BASE where they enter their projects in regional science fairs. Although this project did not determine if students were motivated to pursue these opportunities as a result from participating in the week-long program, opportunities like these could be supportive in students’ development of a positive science identity.

A growing body of work suggests that place-based pedagogy can play an important role in the science curricula of urban schools (Lim, Tan and Barton, 2013; Adams, 2012). If localities develop curriculum to support the interests and needs of the communities in which they are situated, not only will communities benefit but, so will students, as their interest in science is enhanced through relevant, real world application rather than mere test preparation (Smith, 2007). It is important for teachers and school administrators to recognize the importance of relating science learning to physical contexts in which students have their lived experiences, like
what was done in this project, in order to increase student interest, especially among urban and underrepresented students.

This project is a model for high schools, colleges, and organizations to work together to offer relevant science learning experiences. Partnerships are key in developing engaging place-based science learning experiences for underrepresented students (Adams, 2012; Bouillion and Gomez, 2001). Community-based partners could offer the context for the real-world issues that students could address while university faculty could offer the scientific and educational expertise to work collaboratively with schools to plan and facilitate research activities. It is also important to include students in the planning process as they will help to provide feedback about what kinds of activities and questions would engage their peers. Partnerships take time to build but could be rewarding. With strong partnerships there are great possibilities for developing place-based curricula and inspiring the next generation of STEM professionals.

As place-based education increases in popularity, teachers, researchers and community partners will need a) methods of inquiry into teaching and learning science connected to place and b) frameworks on which to design curricula and student-learning experiences that are based on and relevant to the local environment. This is of special importance in urban contexts, where there is often a misconception of the lack of viable greenspaces available to engage in meaningful environmental studies. This project describes a method for teachers to develop critical place-based pedagogies in urban schools. This project also indicates that the local urban environment provides ample opportunities for developing scientific questions and stimulating interest in the geosciences and allows students to make the connections between geoscience concepts and their local environment. Extending this knowledge-base is important for those who
are engaged in research and teaching and learning in a variety of contexts, both in and out of the formal classroom.
Identities and Awareness of Women of Color in Science, Technology, Engineering, and Mathematics (STEM)

“I know the higher I go the fewer of my kind there will be” (Cynthia, personal communication, October, 2012). Cynthia is a tenth grade Caribbean American student at the science themed public high school where I teach life science and do ongoing research on teaching environmental science in an urban context. We were discussing her desire to pursue a science major in college when she surmised that there are fewer black Caribbean American women in science majors in universities and in science fields. This statement is not misguided. Women, particularly women of color, are underrepresented, especially in the physical sciences (NSF, 2011). Only 19% of bachelor degree engineering graduates were female, 25% of graduates in mathematical/computer sciences were female, and 41% of graduates in physical sciences were women (NSF, 2011). Only 5% of science bachelor’s degrees were awarded to black females in 2006 compared with 37% awarded to white females (NSF, 2010). Additionally, 4% of science masters degrees were awarded to black women compared with 30% awarded to white women (NSF, 2010).

I learned about Cynthia’s perceptions of women of color in STEM through ongoing dialogues with her about her science experiences and interests. This caused me to reflect on my own positionality as a white woman in science and also as a white teacher of science in a school with predominantly students of color. The dialogues with Cynthia allowed me to explore the intersectionality of race, gender and STEM through a critical race theory of “whiteness”
(Frankenberg, 1993). While discussing the inequalities and challenges women of color face in STEM, I critically look at my identity as a teacher in a school with primarily students of African descent. In this chapter, I will use a lens of critical race theory and identity development to explore the challenges of Cynthia, as a young woman of color in pursuit of STEM, vis-à-vis me, as a female white science teacher and her mentor, while reflecting on how our identities are discursively shaped through our experiences and discussions.

**Conceptual Framework**

**Identity**

Identity is an important lens for considering how we learn and interact with science (Brickhouse & Potter, 2001; Brown, 2002). Identity development is a process; it is ongoing and occurs in relation to the fields of culture in which we interact. Our identities are formed as we learn culture and find ways to meaningfully contribute to a given field of culture or community (Stetsenko, 2008). We each have multiple aspects to our identities; however, we will enact different aspects depending on the field of culture, the resources, schema and practices we have access to at the time (Bourdieu, 1993; Sewell 1992). Science-related identities refer to an individual’s sense of who they are, what they believe they are capable of, and what they want to do in relation to science (Brickhouse & Potter, 2001). One researcher coined the term “science affinity identity” specifically in relation to students of color (Gray, 2013). Gray describes this as the level of students’ affinity with science which directly impacts students’ degree of participation in science. Science identities include our active participation and role in activities, our ideas, and questions we have about science both in school and in our lived experiences. In addition, we may have multiple science identities depending on the fields in which we learn and enact science practices. Both Cynthia and I build science related identities as we interact with
each other, individually and collectively, in a science classroom and in the larger science community.

**Women and Women of Color in STEM**

There is much research surrounding women in STEM and a growing body of research addressing women of color in STEM (Johnson, 2011). Although women currently obtain a slightly greater percentage of bachelor’s degrees in the sciences than their male counterparts (black men 2%, black women 5%, white men 30%, white women 37%), women of color still remain underrepresented in STEM baccalaureate degree completion and the number of women, especially women of color, in STEM careers still lags behind the number of men (NSF, 2010; Ong et al, 2010). Women in science are faced with challenges such as: entering a mainly male profession with gender bias, balancing family obligations, lower expectations, a competitive stressful work environment, and lack of mentoring opportunities (Eisenhart & Finkel, 1998; Seymour & Hewitt, 1997). Women of color face a “double bind” of gender and race in STEM as the challenges are greater for women of color than for white women or men (Malcom et al, 1976; Ong et al, 2010). These challenges for black women include social factors such as stereotypes about who can “do” science (Carlone & Johnson, 2007; Ong et al, 2010). As science educators, especially those who teach students from underrepresented communities, we need to be aware of the challenges that our students will experience as they endeavor to enter STEM fields.

**Whiteness**

Although there is a strong body of literature that questions the power of Western modern science (WMS) and describes WMS as coming from a dominant culture with a particular set of ideals (Aikenhead & Ogawa, 2007), “whiteness” is a concept that has not been thoroughly
explored in science or science education. It is a critical race construct that refers to how being white places one in a position of privilege and power (Frankenberg, 1993). In the United States whiteness is connected to hegemony and meritocracy (Kincheloe & Steinberg, 1998). Whiteness goes beyond the color of one’s skin, and is more than an ethnicity, but is a powerful, society-shaping force (Kress, 2009). Whiteness is generally enacted on an unconscious level as behaviors are compared to a “white norm” (Kress, 2009). This normative discourse oppresses those outside the dominant culture and can silence those with less power (Rodriguez, 1998).

Frankenberg (1993) notes that white women are “race privileged” and are not in a structural position to see the effects of racism on our lives or in U.S. society. White women who are not exposed to diversity often do not pay attention to issues of race since they do not consider themselves racist and therefore they feel that they do not have to concern themselves around race-related issues (Frankenberg, 1993). As white people in the United States hold political and economic power, this apathy maintains the racist system that is currently in place and results in maintenance of the status quo. On the other hand, those who are subjugated tend to see the oppressive structures of society more clearly and have a more critical view of these structures (Frankenberg, 1993; Freire, 1970). However, they often lack the political and economic power to enact systemic change. The role of educators should include raising critical awareness of unjust policies and practices of society (Freire, 1970). Prior to teaching from a critical perspective to work towards equity, educators must develop an awareness and understanding of racial inequalities. Learning how my privileged history and privileged present is dialectically related to the unjust historical and unjust present circumstances of others is a step towards understanding whiteness and identifying myself as a racialized being (Kress, 2009). A lens of whiteness allows us to examine how racial privilege perpetuates inequalities. Adapting this lens has allowed me to
reflect on my own privilege vis-à-vis my students and empower me to work against biased systems.

**Case Study Using Cogenerative Dialogues**

This case study is a part of a larger research study that examines teaching environmental science to underrepresented students at Brooklyn Academy of Science and the Environment (BASE), an urban high school. The research took an ethnographic approach with cogenerative dialogues (cogens) (Tobin & Roth, 2006) as the primary methodology to learn about student experiences in an outdoor place-based science class called Field Studies. Cogens are a forum for teachers and students to engage in conversations and reflect on teaching and learning experiences together by providing a social space where all participants can connect as equals (Tobin & Roth, 2006). Cogens provide space for teachers to engage in reflective practice and can potentially improve power dynamics in urban classrooms as teachers practice “sharing control” with students regarding aspects of classroom practices, curriculum, and teaching style to create more equitable and enjoyable learning environments (Bayne, 2009). Cogens are saturated by macrostructures of social life, such as race, and can be a place where participants become critically aware of sources and forms of oppression (Elmesky, Olitsky, & Tobin, 2006). Additionally, teacher-student relationships may improve despite gender, racial, or class barriers (LaVan & Beers, 2005). Cynthia emerged as a case study because of her dedication to attend the cogens in ninth grade to discuss her experiences in the Field Study and Living Environment classes, and her willingness to continue to meet in tenth grade to discuss her developing interest in science and her Earth Science and Science Research classes. In addition, I became interested in learning more about Cynthia’s experiences because of her interest in pursuing a science career after high school and my questioning of my role in mentoring her through this process.
Cogens were held once a week, over a period of two years, during lunch and afterschool. The first year of cogens were with a small group of two to four students from Cynthia’s science class. The meetings were voluntary, so the number of students varied from meeting to meeting. When Cynthia emerged as my case study, we continued with one-on-one cogens during the second year. These cogens provided a space where Cynthia and I were able to discuss her science experiences, interests, concerns and goals, and I discussed my experiences in science and teaching and my intentions for the activities during the science lessons when she was in my class. Putting the lens on Cynthia forced me to turn the lens on myself, and I used auto/biography and auto/ethnography (Roth, 2005) to explore my own life experiences vis-à-vis Cynthia’s. Auto/biography and auto/ethnography dispel the myth that research is objective, as this methodology requires the researcher to reflect on her own life and experiences in the context of society in order to position herself in her research. This was especially critical in my research, where examinations of race relationships in terms of white privilege are not common.

**Reflections for Understanding**

I used a constructivist grounded theory framework that recognizes the centrality of the researcher’s prior experiences, perspectives and relationships to both the phenomena and participants in the field (Charmaz, 2005). This allowed me to use both Cynthia’s and my narratives to explore the intersectionality of race, gender and STEM identity through our dialogues and relationship. As a researcher from a critical perspective, I admit that I am unable to disconnect my research from my own positionalities with respect to race, class and gender (Kincheloe & McClaren, 2008). I also employed “restorying” (Cresswell, 2007) wherein I reorganized our narratives into an emerging framework of patterns of STEM identities in relation to race and gender.
The Specter of Stereotypes

“Unfortunately I can’t post my grades on my face so people aren’t like, ‘oh yeah you’re smart’. I think people look at me and they already prejudge me…even people of my own race” (Cynthia, personal communication, October 2012). As a tenth grade student Cynthia was already aware of the stereotypes against her entering a science field. Cynthia knew that there are women scientists and that she is capable of entering a science profession, but she was aware that there are social factors of race and gender that work against her efforts to become a scientist. Cynthia felt like she had to prove to herself and others that she is smart and that she is not “rambunctious and loud,” as she describes how she felt she would be perceived as a black female.

I feel like it’s just me trying to cope with myself in a way. I know I was born like this and it comes with certain stereotypes. So in order to cope with that I try to do better than everybody else to prove I’m not what you think I am. (Cynthia, personal communication, November, 2012)

Cynthia worked hard to counter the negative stereotypes acting upon her. Getting good grades in school was one way that Cynthia enacted her identity of “being smart” in order to overcome the “stereotype threat” of black students not being academically capable (Steele & Aronson, 1995). Cynthia used the resources of studying and getting high grades to enact an identity that was congruent with what she believed about herself, in spite of how others may have perceived her.

When I first entered the urban high school science classroom as a young white female from the suburbs, I was unprepared to overcome the differences between my students and myself. According to the U. S. Department of Education (2012) in 2007-8, 76% of teachers were female, and 83% of public school teachers were white, 7% each were black or Hispanic, 1% each
were Asian or of two or more races, and less than 1% were Pacific Islander/American Indian/Alaskan Native. By comparison, the demographics of students enrolled in public elementary and secondary schools were: 56% of students were white, 17% were black, 1% were American Indian/Alaskan Native, 21% were Hispanic and 5% Asian/Pacific Islander (National Center for Education Statistics, 2010). While there is a growing number of underrepresented students in schools (U.S. Census Bureau, 2000) there is still a predominant cadre of young, white, middle class women teaching them (Wallace & Brand, 2012). I am not alone in that many of these women also feel unprepared to work with culturally diverse students because of possible behavioral or cultural differences (Martin & Lock, 1997). As a teacher-candidate I had insufficient intercultural contacts and was not provided with the enriching direct experiences that Settlage (2011) claims are necessary in teacher-education programs. My science students’ lack of experience with science phenomena is viewed as solvable by engaging them in authentic science activities that allow them to learn the culture of science, including the tools and language used by scientists. Similarly, instead of holding a deficit view of teachers like myself, with limited experience with people from culturally and linguistically diverse backgrounds, teacher educators should provide enriching direct experiences for learning to dispel misperceptions (Settlage, 2011). Cochran-Smith (2000) explains, helping future teachers recognize racism in its many forms, guiding them to accept the significance of their cultural heritage, and assisting them to reject a colorblind perspective are important for becoming effective teachers of culturally and linguistically diverse students.

When I completed my student teaching in a middle class suburb of Long Island, N.Y., I was concerned about being accepted as a teacher because I was young and looked like my students. The security guards often asked me for my hall pass. When I started teaching in
Brooklyn, I was again worried about being accepted by my students as a teacher; however, in this case it was because I didn’t look anything like my students. When I taught, I was the only white person in the room, and I was the “authority figure” teaching science, a subject that I felt people often perceived as exclusive and rigid. I often wondered what stereotypes my students held about me as I stood in front of the room.

I had my own stereotyped preconceptions of the neighborhood, the school, and students when I started teaching in Brooklyn, NY. Upon entering the school for the first time, I didn’t know if the metal detectors used for scanning made me feel safe or more vulnerable. I had never been in a school with metal detectors. The scanning to get into the building signaled to me that outside the school was not safe. As I walked through the halls at my new school, I noticed, for the first time in my life, that I was in the minority. I was used to always being surrounded by people who were just like me. Walking around the neighborhood surrounding the school, I felt uncomfortable and wondered what the neighbors thought about the white girl in their space. I was on edge to be on the street alone. I felt that I stood out as a white person in these new places, and my perceptions and stereotypes of the neighborhood were that it was not a safe place for me to be alone. According to my father-in-law, a retired police officer who grew up in Brooklyn, the area surrounding the school had a history of drugs and violence. Because of this, I assumed that the young and middle-aged black men standing on the corners and around the bodegas were selling drugs or up to no good.

However, I quickly became used to the surrounding neighborhood. I felt that it was obvious to the residents that I worked at the nearby school because the only other white people on the street that I observed were the other teachers. I actually felt like some people were looking out for me, knowing that I was a teacher nearby. Over time I became more comfortable
in the school, and I rarely noticed being the only white person in the hallways. Inside the school there were very few white students, and most of the white people worked at the school as faculty and staff, so it was apparent to students that I was a teacher.

I also held preconceptions about my students of color when I first started teaching at BASE. I believed that most of them were poor, might have unstable family situations, and had below average literacy skills. When I began teaching at BASE I had to adjust my teaching to align with my students’ literacy levels, which, overall, were not as developed as the students in my suburban classes. Like many other white teachers, this resulted in deficit perspectives of my students of color. I had lower expectations of them because their cultural differences didn’t coincide with white culture (Villegas & Lucas, 2002; Boykin, 2008; Ladson-Billings, 1994). However, despite my deficit perspectives I always held the belief that all students were capable of learning, and I wanted to be the best teacher I could so that my students could do their best, regardless of their backgrounds. I faced my deficit perspectives while I was enrolled in graduate courses learning about culturally responsive pedagogy (Villegas & Lucas, 2002). I became a better teacher as I learned to treat students as individuals, not to play into my pre-existing stereotypes, and to recognize and avoid deficit perspectives.

Although I became more comfortable with my surroundings at BASE I wondered what stereotypes my students had about white people and about me. Ladson-Billings (1994) claims that black students need to see more teachers who look like them to raise their self-esteem and to help them know they can succeed. As a white teacher, I questioned this notion and wondered how much it mattered to my students that I was white. Was I succeeding in making science learning relevant with culturally appropriate examples for my students? Were students wishing
they had someone who looked differently, maybe someone that they felt they could relate to better?

**What does a scientist look like?**

One activity I always do with my ninth grade classes at the beginning of the year is the Draw a Scientist test. I do this because I am always curious about the notions of being a scientist that students enter the class with and to see if their conceptions of being a scientist and doing science changes with the Field Studies class. During the year that Cynthia was in the ninth grade, most of my students drew pictures of white men wearing lab coats with crazy hair and glasses working with test tubes and Erlenmeyer flasks. A few students drew female scientists or scientists outside of a lab setting. Cynthia drew a female scientist in a lab coat at the beginning of ninth grade (Figure 8). This indicates that Cynthia’s idea of a scientist included one that went beyond the stereotype; one that was female and somewhat looked like her. However, her notions of what a scientist *does* changed from one who works in a lab to one who worked outside in the rainforest researching frogs, wearing jeans and a tee shirt (Figure 9).
Figure 8. Cynthia’s initial scientist drawing. “I think scientists usually look like the picture I have drawn below. The usual lab coats and goggles are the norm.”
Counter to the traditional stereotype of men as scientists, it was encouraging for me to see that Cynthia drew a women scientist. The drawings of Cynthia and her classmates helped me to understand their notions and stereotypes of scientists and opened up a conversation around how we all are scientists in different ways. For example, when we decide what to wear in the morning we are acting like scientists. We hypothesize what outfit will look good, we follow a procedure to get dressed, we determine our results by looking in the mirror and seeing what we look like, and if necessary we revise and retest by changing our clothes. In this lesson I also discussed how there are fewer black people and women in the sciences and that all groups should be equally represented. Although students’ drawings helped me understand their perceptions of scientists, I
wondered: what are my students’ perceptions of who could be science teachers? As I was becoming aware of my whiteness these questions arose in my mind, and I didn’t address them until several years later when I began discussing issues of race with my student Cynthia.

**What does a good teacher look like?**

Whiteness considers how the social construct of race in the United States positions white culture in a position of power over “other” ethnic groups. As I became aware of my whiteness and how this has privileged me through my life, I developed another lens for why I was uncomfortable “taking control” of my high school classes. As a new teacher, I was concerned about classroom management and believed the stereotype that a good teacher should have “control” over students. When I began teaching I found I was always backing down to students, afraid to challenge them and assert my authority as a teacher. I believed that “losing” arguments with students would compromise my control of the classroom. I also didn’t want to be labeled as being mean or unfair. For example, if a student asked to use the bathroom pass in the middle of an activity, instead of telling the student to wait until the activity was finished, I would give in and let him use the pass rather than risking a disruptive argument. The main reasons I often gave in were: I didn’t want to disrupt the entire class and derail the learning of other students if I got into a confrontation with the student, and I didn’t want students to just take the pass and walk out of the class without permission because then I would have to write up a dean’s referral for insubordination. Writing too many dean’s referrals about “incidental things” indicated to my principal that I had poor classroom management, not to mention the deans were so busy with other bigger issues that students rarely faced consequences for such a write-up. I imagine I lost some students’ respect when I began teaching by compromising all of the time and not being stricter; however, I think that I was successful in not escalating certain situations. At the time I
thought that I was not a good teacher because I didn’t have enough control of the class, but I believed that it was important for the teacher to de-escalate situations in the classroom while maintaining authority.

Through my teaching experiences and cogens with students, however, I have understood that my stereotype of a good teacher as someone who has control over the class, is not necessarily the best teacher. I have realized the importance of teaching and learning “with” students by providing opportunities for student voices to be heard to create more of a shared responsibility in maintaining a safe and equitable teaching environment. My compromising with potential “incidental things” was partially a result of lacking classroom management skills as a new teacher. Upon reflection I also realized that it was partially because of race-- I was insecure in my role as the only white person in the room and as the authority figure. My differences from my students added to my fear of being challenged by students. I feared that students would think “who is this white lady coming in here telling us what to do, who does she think she is? She doesn’t know me.” In fact, I had to earn the respect of my students. I wasn’t granted respect from all of my students just because I was an adult or a teacher. This was different from when I grew up in the suburbs and automatically gave respect to my teachers. It was also different from when I was completing my student teaching in the suburbs in a setting where I was more comfortable. When student teaching I was also nervous about students challenging me in the classroom and I had to develop a reputation with students; however, I felt more justified in asserting my authority because I was more familiar with my surroundings and had a cooperating teacher supporting me in the classroom. In my new setting in Brooklyn I had to prove myself and develop a reputation as a “good” teacher with students and align myself to the cultures of my students and the school. Since students act differently with different teachers, I felt that if students heard from each other
that I was a good teacher, they would have more respect for me from the beginning of the school year.

As I learned more about my students and they learned more about me, my students understood that I was there to support them and that I cared about them. I felt like I gained their respect although I still struggled with understanding the silenced issue of the racial inequalities my students faced, especially in the sciences, and how I, as a white teacher, represented white society to my students. As I continue teaching in a diverse setting I realize the importance of understanding racial inequities to develop sociocultural awareness and develop culturally responsive teaching practices (Wallace & Brand, 2012).

**Using Race as a Lens and as a Mirror**

“I feel I probably have to work twice as hard as other people so I can be accepted in anything. Just me being my race puts me back. It’s almost like a hierarchy.” Cynthia often reflected about her challenges of being black; she seemed to view blackness and achievement as in contradiction. This made me more aware of my racial privilege because like many white teachers, I was never in a situation where I had to examine or reflect on my race before I started working in an urban high school. I didn’t realize all of the privilege that my race has afforded me throughout my life until I began talking with my students about their experiences with race.

Recognizing Whiteness and all the implicit norms and assumptions that come along with it is essential for helping educators to move beyond understanding their minority students in relation to themselves and into understanding themselves in relation to their minority students. It is in this reciprocal process of identity transformation, of understanding self
through others and others through self, that social change truly can occur. (Kress, 2009, p. 9)

Unfortunately whiteness is hidden from many white peoples’ eyes (Frankenberg, 1993) because of the normativity of being white in our society. Since we are all historically situated beings, white educators need to understand how our students view us and the historical factors that have shaped race perceptions and relationships in the United States (Kress, 2009). In addition, educators need to have a critical understanding of the societal structures that continue to perpetuate a racial hierarchy and how our students of color interface with these structures. Through critical understandings of self vis-à-vis Others, we are better positioned to work towards educators’ identities that enact equitable teaching and learning and advancement for all students.

I began my exploration of my identity and whiteness by learning more about Cynthia’s Caribbean American heritage, including her family’s traditions and religious beliefs, while learning more about my own heritage and identity.

Reflecting on my teaching with a lens of whiteness, I questioned if my students felt more of a desire to challenge me and test me because I am a white female. It is possible that students wanted to challenge me because whiteness represents a society that oppresses people of color and I represented the oppressor. Whiteness sustains Eurocentric worldviews through policies and influences the distribution of power and resources and the extent of social control that is afforded to people (Sammel, 2007). I had an “a-historical identity” (Kress, 2009) where the connection between whiteness as a form of domination and cause of suffering was erased and never surfaced in my identity as a white person. Whiteness was all around me my whole life, but whiteness is generally invisible to the dominant group, so I never had to apply race to myself (Grover, 1997). I didn’t know many black people growing up and I had very few black people in my college
classes; however, I never thought about why my experiences lacked this aspect of cultural diversity until I was surrounded by people of color. I didn’t question my race until I was the “minority” as a white teacher in a classroom of students of color. I became more aware of whiteness and faced an identity as the racial oppressor for the first time. I did not want to be associated as someone with unearned power and privilege (Grillo & Wildman, 1995). I avoided discussing issues of race in the science classroom because as I was coming to awareness of my own whiteness and racialized self, I was becoming more aware of the racial power dynamics that exist between me and my students, and it made me uncomfortable.

“It’s because I’m black, isn’t it?” The first time a student accused me of treating them differently because of their race I froze, afraid of how to respond. The student was joking, but I took this accusation seriously and replied, “I do my best to be as fair as possible with all of my students. Did you happen to look around the class lately?” implying that the class was mostly black students. I responded hesitantly because I felt like I was being stereotyped as racist toward black people. Although this was a joke to this particular student and several other students who were laughing at the comment, I was uneasy joking about this topic. I certainly did not want to be accused of being racist. According to Frankenberg (1993):

To speak of whiteness is, I think, to assign everyone a place in the relations of racism. It is to emphasize that dealing with racism is not merely an option for white people- that, rather, racism shapes white people’s lives and identities in a way that is inseparable from other facets of daily life. (p. 6)

As I became more aware of my whiteness Frankenberg’s description of how we all have a relation to racism in one way or another rings true, especially in recognizing my unease in being labeled racist.
When I first started teaching at BASE I did not consider how uncomfortable I was with being labeled as racist because I am white. I also never considered the identities of different groups of black people and grouped all black people in the same category. In my Living Environment class I had several Fulani-speaking students from West Africa who were all friends. This group often talked to each other in their native language and in English during class when we were taking notes. They were still learning English and needed extra support for reading and writing assignments. I regularly had to stop class to remind these students not to talk to each other across the classroom while I was giving the direct instruction portions of the lesson. One of the students from Gabon, who learned Fulani from his Fulani speaking friends, would say offensive things to other students in the classroom and try to draw them into arguments. During class one day, this student and several of the other African students accused me of discriminating against them and picking on them. I found myself incredibly defensive and enraged that the students would accuse me of this. I had to take a deep breath and calm my nerves in the moment. Later I had a conversation with the students, with the guidance counselor as a mediator, because this was such a sensitive topic for me to approach. With the guidance counselor as a third party, I was able to discuss with my students why they felt this way and how in reality I was treating them fairly. My West African students felt that I was treating them differently from the Caribbean American, African American, and Latino/a students. This scenario reflects how African immigrant students identify differently than other students of color and it also demonstrates how defensive I was about being called racist or discriminating. Learning about whiteness has helped me understand my “white guilt” because of how people of color have been treated in the past and are presently treated. I didn’t want to be labeled with the stereotypes associated with my white skin and was not comfortable with this aspect of my identity.
My students have exposed me to much more diversity than I was once familiar with and as I became more aware of identity differences of ethnic groups, I worried that my newly immigrated African and Caribbean students might be feeling effects of discrimination in America based on their skin color which they didn’t face in their home countries. For example, Cynthia’s parents did not feel the effects of racism until they moved to the United States. The idea of “stereotype threat” refers to becoming aware of the negative stereotypes of blacks in America and the negative effect of these stereotypes on black peoples’ performance (Steele, 1997). According to Deaux, et al (2007) first and second generation West Indian immigrant groups demonstrated different degrees of stereotype threat, where the second generation underperformed the first generation. Deaux, et al (2007) further explain this is potentially because of the increased awareness in the second generation immigrants of the negative stereotypes towards blacks in America and the stereotype threat that is imposed upon them.

Reflecting back to when my students claimed I was treating them unfairly because they were “black”, they may have been referring to how their identity of “black” was different from their classmates’, despite the color of their skin being “non-white.” Just as my African students perceived they were being discriminated against because of their African identities, this student may have been implying that he was being treated differently as an African American than other cultural groups in the class. Working in a more diverse setting than what I experienced growing up challenges me to learn more about the Other while becoming more aware of my own Otherness. I have learned a lot about classroom management through my teaching experience and can comfortably assume the role of a “good teacher,” which is more of a facilitator than dictator, and I no longer worry about feeling like I am the white person telling the black person what to do. I felt uncomfortable as the “authority figure” because in American society white
people are privileged at the expense of blacks and other underrepresented groups, and I didn’t
want to reproduce this white hegemony in my classroom. I struggled with my identity both as a
white person and as an instructional leader in the classroom. I learned from my students in
cogens to become more aware of how the racial hierarchy in this country intersects with
students’ lived experiences on a daily basis and how to afford students more agency in the
classroom through my approach to teaching and learning with students instead of my initial ideas
about controlling students. Because of my limited background, I have to learn more about other
peoples’ cultural identities and how these groups perceive each other in order to be successful
teaching in a diverse urban school. I never would expect anyone to think of me as racist;
however, according to Frankenberg (1993) I could do more to overturn racism. For example, my
inaction in a formal anti-racism organization may perpetuate the current discrimination in
American society. However, through cogens with my students we are raising awareness as we
learn from the other, and have the potential to make more students aware of sources of inequity
(Elmesky, Olitsky, & Tobin, 2006). My students of color notice and feel the effects of
discrimination and have increased my awareness of this issue as I teach in a more diverse setting
than what I was previously familiar with.

During my early years of teaching, I endeavored to learn more about my students and
overcome my stereotypes of them and have them learn more about me by asking about their
interests and background during class while sharing similar information about myself. I became
more aware that learning about the ethnic backgrounds of my students and the stereotypes that
they hold against other groups is an important part of understanding classroom dynamics. It also
made me become more aware of my stereotype of blackness or being African American as a
monolith. I became more aware of intra-race cultural differences and how this influences the
relationships between students, by speaking with other teachers and talking with students. Later in my teaching, my conversations with students turned into cogens focused around experiences in science class held after school or during lunch. I believe I was successful in teaching most students when they understood that I held high academic standards for all my students, and most importantly that I cared about them. I am appreciative that my discussions with Cynthia in particular have made me re-examine my stereotypes, my own identities and my teaching practices, and have helped me come to an awareness of my whiteness.

**Encouraging Interests While Recognizing Challenges**

Cynthia plans to go to college to study science but knows that she will not encounter many people of her race in her major. As she noted in the opening quote, there are not many of “her kind” in the science majors and fields. There were only 5% of science bachelor’s degrees awarded to black females (NSF, 2011). As a mentor, I often talk to students about their college plans. The dialogue between Cynthia and me led to our discussion about black women in science. At this time I had taught in this school for six years, yet I found myself totally unprepared for a discussion about racial disparities. As a teacher I feel it is necessary to encourage and support students to pursue their interests while being realistic about the trials involved in reaching their goals. As a white woman I have not faced the same challenges that Cynthia faces as an Afro-Caribbean-American young woman, and this inability to relate to Cynthia’s experiences made me feel especially awkward in discussing race issues and stereotypes.

This was one of the first times in my life where I felt required to explain institutionalized racism and other race-related challenges; however, I was at a loss for words. At times I didn’t know how to respond to Cynthia’s comments other than to say: “Yes, you are right, society is not
fair” and I was unable to offer any advice or solutions. I could not claim an understanding of her feelings because my race afforded me different experiences and perspectives than hers. The stereotypes that I faced as a white female teacher did not have a large negative effect on my life unlike the stereotypes that Cynthia faces as a black woman in science. I have never felt discriminated against or felt I was treated unfairly because of my race. We were, however, able to find common grounding in discussing the challenges I faced as a woman and her being an emerging woman in science. Women are still underrepresented in science fields (Ong, 2010). We discussed stereotypes of women in relation to science, such as that women are not as capable as men in science fields, and I shared ways that I coped when faced with related challenges such as the competitive dynamics of my college science courses.

I then turned the lens on myself, using auto/ethnography, to reflect on and share my experiences and perspectives as a white female teacher at the school and when I have felt stereotyped, when I have been positioned as a minority, and my difficulties teaching in a school with all students of color. This was the first time that I had shared with a student about my own uneasiness of being a white teacher in a majority black school and my concerns of how my students may have perceived me. As discussed above, as a white teacher in an urban classroom I question whether my examples of why science is important to our everyday lives are culturally relevant to my students, if my students will trust me and open up to me, and if my students think I am acting unfairly to students of different races.

I also shared with Cynthia my concerns about balancing my family life as a new mother with my professional life, a challenge that is unique to women. The attrition of women in the sciences is greatest among married women with children (Goulden et al., 2011) and motherhood has been listed as the most important factor that results in women leaving a scientific career.
(Ceci & Williams, 2011, Goulden et al., 2011). As a new mother and a science teacher I have often felt torn between working and staying at home to raise my children. Women with children in the U.S. are more likely to leave science than are single women or men, and having children appears to have no negative impact on male retention in science (Goulden et al., 2011). Growing up I never thought about how I would balance a family and a career. Now that I have a growing family, my identities as a mother and a professional are in flux. I entered teaching because I thought it would be a good career for raising a family and still hope that will be the case. Women in other science careers who have longer hours, more competition, and less vacation time might face more stresses balancing work and home. As a young woman still in high school, Cynthia has not considered how she will balance home life with professional life, and she has plenty of time to figure that out; however, it is a challenge that women face, especially in the sciences. Through our discussions, I learned more about my positionality vis-à-vis Cynthia and my other students. As identity development is ongoing and discursive, our dialogues were not only critical to Cynthia’s and my understanding and building trust in one another, but also important identity development events for both of us.

**Identity of Place: Cynthia’s Caribbean Connections**

While race and gender play an important role in identity development, so do cultural connections and peoples’ connection to places (Adams, 2013). Cynthia’s mother immigrated to the U.S. from Trinidad, and her father emigrated from Guyana. Cynthia has fond memories of her visits to Guyana and recognizes her ethnic heritage as a strength. Cynthia told me that her parents were so strict with her because of their Caribbean backgrounds. She described this as a strength of her culture because it kept her focused on her school work. Some of the sessions in the Field Studies class took place in the Tropical Conservatory and Education Greenhouse at the
partner botanical garden. In the Education Greenhouse rooms, students completed a scavenger hunt and were asked to identify plants with different qualities, for example, plants that were used as spices in cooking, or plants that we eat that are roots. In the Tropical Conservatory activity, students observed flowers and plant adaptations to living in a wet environment such as the rainforest. In this setting, Cynthia was able to draw upon her cultural resources and lived experiences to connect with the science around tropical plants. Cynthia was able to both share her existing knowledge and gain new knowledge of tropical plants. She reflected on her experiences visiting family in Guyana and the similar plants she encountered there. Experiences in these contexts allowed Cynthia and other students of Caribbean descent to connect to their Caribbean identities by giving value to their knowledge of the characteristics of tropical plants and their uses. I especially enjoy visiting the Tropical Conservatory with students from tropical regions because I also learn from them both about what they know about this environment and the memories that they share of other people and places as a result of being in a space that evokes the tropics, a place that is familiar to them and tied to their identities.

The Field Studies class is also held at the large local urban park. Although this setting is very different from the Tropical Conservatory, Cynthia was still able to make connections between this place and her Caribbean place-related identity. During an activity when we were observing decomposition in the forest ecosystem, Cynthia’s group overturned a decaying log and found a slug. This was a big excitement for her group of four students since most students had never touched a slug before. Other students in the class were also very interested in their find. Later in our cogen Cynthia reflected and described how the woods reminded her of visiting family in Guyana. Cynthia shared how the slug reminded her of frogs that would cover the entire yard in Guyana. Cynthia wondered if salt would affect the slugs in the same way that it “took
care of” the frog pests. This led us to a discussion about diffusion and how putting salt on a slug would dehydrate it and eventually kill the animal. Connecting new discoveries with students’ prior knowledge and experiences validates their knowledge and leads to increased understanding of new concepts (Basu & Calabrese Barton, 2007). As Cynthia shared her Caribbean identity it made me wonder more about my own heritage.

I found it fascinating that many of my students, or their parents, like Cynthia’s family, were new to the U.S. I have had students from Bangladesh, Africa (Guinea and Gabon), the Caribbean (Jamaica, Haiti, Puerto Rico, St. Lucia, Guyana, and several other islands), South America, Panama, and Mexico. At the beginning of the school year I share with my students that I am from Toronto, Canada, Boston, MA and Buffalo, NY. I never traced my heritage past that level. I was inspired by my students and my cogens with Cynthia and her classmates to look further into my heritage to better understand where and when my ancestors immigrated to the United States and learn about my ethnic identity.

**Becoming White**

I began investigating my own ethnic identity by asking my parents about our family history. The percentages of my heritage reflect an ethnically mixed background. I am 1/8 Irish, 1/8 French, 1/8 Welsh, 1/4 English and about 3/8 Scottish. It is challenging to study ethnicity because there are differences within ethnic groups in terms of acculturation, generation of immigration, social class, and regional differences (Phinney, 1996). People differ in the degree to which they have joined American society and the increasing numbers of people from mixed ethnic backgrounds, such as myself, cannot be assigned to a single group and therefore blur the boundaries of ethnic groups (Phinney, 1996). Ethnic identity changes over time and context and involves how we understand and interpret our own ethnicity and varies depending on the degree
to which we identify with our ascribed group (Phinney, 1996). My more recent relatives acculturated to the American way of life and were not focused on maintaining an ethnic identity with their parents’ original countries. My great-great grandparents on both my father’s and mother’s side emigrated from Scotland, Ireland, France, and England to Canada. My father was born in Boston (raised Catholic) and lived there until my family moved to Buffalo, NY. My mother was born near Toronto and lived there until she met my father and moved to the Boston area.

Aside from growing up in Boston and Buffalo, my identity has been shaped by spending my summers “at the cottage.” My great grandfather bought property on a lake in Northern Ontario, two hours north of Toronto and my grandmother, my mother and my brothers and I have all spent our summers growing up there. My summer experiences in Canada and my mother’s Canadian citizenship are why I identify as half Canadian and feel I need to share this part of my identity with my students when they ask where I’m from. Many white people, like me, and especially those with mixed ethnic backgrounds, only celebrate selected pieces of their heritage over time as their families assume American culture. Learning about my ethnic identity gives me perspective for comparing and appreciating the differences of others.

There is a long history of prejudice against immigrants on the basis of race and identity in America. Many immigrants in the wave of European immigration from a hundred years ago assimilated to American culture and were “Americanized” upon their arrival to the United States. Children of European immigrants were often embarrassed by their parents’ old country ways and accepted American culture (Foner, 2012). When European immigrants first arrived the differences in their sending countries did matter, especially for Jewish and Italian immigrants who were not viewed as “white”, as were the people with origins in Northern and Western
Europe (Foner, 2012). However over time, these people were able to blend into white society and more easily avoid discrimination compared with today’s immigrants who are predominantly people of color, and therefore face continued discrimination in American society (Foner, 2012). As a white, Protestant female, growing up I never needed to question where my family originated from, nor was it ever a focus for me living in the suburbs of Boston, MA and Buffalo, NY. As a member of the dominant group, I rarely had to question myself. White Americans have more limited ethnic identities, in the sense that they are not necessarily aware of their heritage, than Asians, blacks and Hispanics (Roberts et al., 1999). This was evident in my experiences growing up when I participated in the American holidays, such as Thanksgiving, and Christian holidays such as Christmas, without question. At one point I questioned what percent Irish I was because I wanted to know if I could legitimately participate in St. Patrick’s Day celebrations, but that was the extent to which I questioned my ethnic identity until I started teaching in a diverse environment. White Americans are afforded the option of choosing to what extent they incorporate their ethnic identities while still identifying as American (Phinney, 1996)

For ethnic minorities of color, identity formation involves developing an understanding and acceptance that one’s group will face stereotypes and racism in American society (Phinney, 1996). White racial identity formation includes becoming aware of the existence of racism and the privilege associated with being white, and developing a nonracist white identity (Phinney, 1996). As I have tried to make sense of my heritage and my whiteness, I have followed a progression described by Helms (1990) termed “White Racial Identity Development”, where white ethnic or racial identity starts with a lack of awareness of the implications of being white, with little or no thought about the issues of race and ethnicity. Then, one recognizes the advantages of being white and learns of the inequalities experienced by minorities. Seeing the
difference between the white and minority experiences creates discomfort, guilt, and denial. This hopefully leads one to reexamine their attitudes and see how they may have perpetuated racism without knowing it, possibly alienating oneself from those who are considered racist. Next, one will try to determine accurate information about what it means to be white in America. Finally, one reaches a positive sense of self as white, understands the need to confront racism and oppression, values cultural differences, and becomes more open to people of color and other groups.

This progression of white racial identity development, as described by Helms, resonates with my experiences as I have come to learn about whiteness through my discussions with Cynthia. For example, before I started teaching at BASE I was unaware of what it meant to be white, then when I started teaching I became aware of the differences between the experiences of white people and people of color. Following Helms’ (1990) progression, this made me uncomfortable and made me feel guilty for being white and benefiting from it without any awareness. I considered my values and how my inaction and naiveté has perpetuated racism. I was worried about being labeled racist by my students. Now, I am undergoing a transformative process to understand whiteness in America to better understand my white identity and determine how I can confront racism and be open to people of color. Although I am not quite at the stage of development where I am totally comfortable with my white identity, I am hopeful that I can address race issues in cogens with my future students in order to raise awareness of whiteness with white people and people of color.

**Transforming Interests in Science as Women**

A person who has a strong science identity is someone who is competent, demonstrates meaningful knowledge and understanding of science content, is motivated to understand the
world scientifically, has skills to perform her competence of science practices to others (by using scientific tools, talking and acting fluently), and who recognizes herself and is recognized by others as a “science person” (Carlone, 2007). Identity is fluid and transforms as people learn in new and different contexts, interact with different people, and learn more about themselves within these contexts and people. Science affinity-identity as described by Gray (2013) is the level of a students’ affinity with science. This is based on one’s sense of compatibility with science, her self-reported achievement in science, the usefulness of science in her life, and her expressed liking of science. Science affinity-identity impacts the student’s degree of participation in science. The higher a student’s science affinity-identity, the more likely she is to view herself as science insiders and actively engage with the science community. Unfortunately, many students who are interested in science potentially view the identity of a scientist as incompatible with their racial/ethnic or gender/sex identities (Gray, 2013). It is evident from talking with Cynthia that she has a strong science-affinity identity.

In ninth grade, Cynthia said, “I know I love science but I don’t know what career to take in science.” When we started cogens, Cynthia was interested in becoming a doctor or researching breast cancer. Cynthia was first inspired to study science because of her father’s interest in human anatomy, whose anatomy books she would read when she was younger. Cynthia’s science interests developed over her first two years of high school as she had more exposure to different fields of science through her classes and participation in extracurricular activities such as the Young Naturalists Club at school. The Young Naturalists Club was held after school at the local urban park, where students performed in depth field studies of the natural environment. Based on her grades in ninth grade and her teacher recommendations, Cynthia was selected to take science research in tenth grade. The science research class is a three year program in which
students are introduced to different fields of science in tenth grade and are partnered with scientists in the community to complete authentic research projects during eleventh and twelfth grade.

After participating in the science research class in tenth grade Cynthia wanted to be a marine biologist, or any type of scientist. “Science research [class] is making me more interested in science. I want to do something that somebody hasn’t done before which seems almost impossible because if you research on the internet everybody’s had a hand in everything.” Cynthia described possibly researching in the deep ocean, where she could discover new life forms or see things that have never been seen before. As we have experiences by participating in communities to reach our goals we learn and our interests and identities transform (Stetsenko, 2008). Cynthia is passionate about discovering new ideas to add to the body of knowledge of science. Cynthia will need continued successful experiences in science and encouragement and support to maintain her intrinsic motivation and pursue her science interests. Cynthia and I plan to continue to discuss our science interests together. It will be interesting to see what college major and career path Cynthia follows as her interests in science continue to transform.

As an undergraduate science major, Cynthia will have to negotiate a culture of white masculine values and norms underlined with the ideology of meritocracy (Eisenhart & Finkel, 1998). Seymour and Hewitt (1997) found science departments were aligned with masculine norms and values, especially the idea of weed-out courses and unfriendly professors. Students of color and white women have more difficulty thriving in undergraduate science than white men, despite their preparation (Seymour & Hewitt, 1997). As a white woman I have a privileged racial status, but a subordinate gender status, which intersect with other aspects of my identity to represent my identity as a science teacher (Case, 2012). I faced the challenges described above in
my undergraduate college program, but in my life experiences I have not truly felt marginalized because I am a woman. As a woman of color, Cynthia’s science identity will be doubly challenged as she continues studying science.

Critical factors in students’ success in undergraduate science degrees include: strong pre-college science experiences, family support, teacher encouragement, intrinsic motivation, and perseverance (Russel & Atwater, 2005). Additionally, Brown (2002) found that growing up in a small supportive community aided student success. Recognition by others is another main factor for women of color maintaining their interest in pursuing science careers (Carlone, 2007). Women of color who formed “research scientist identities” located professors who recognized them as capable students and gave them access to participate in relevant communities of practice (Carlone, 2007). At BASE, Cynthia has opportunities to build a positive science identity both through the support of teachers and feedback from her peers. For example, Cynthia’s science identity was encouraged by her peers during their Field Studies science fair project in ninth grade. Cynthia emerged as the leader of her group of four students and helped direct students in her group, especially during the presentations to the judges. The other students referred to Cynthia to help answer the judge’s questions about their project, which was to determine the health of the urban park’s water system using a biotic index calculated by sampling macro-invertebrates. In eleventh grade, because Cynthia is in science research program, she will be partnered with a scientist from the community to complete an authentic science research project. This experience will afford Cynthia access to participate in the science community of practice and further support her science identity. Cynthia also benefits from the support of her parents. Her father would like for her to enter a medical field and her mother supports her entering any science field. The cogens with Cynthia have afforded me time and space to encourage Cynthia to
continue in the sciences, and I feel like I have been a positive support for her pursuit of a science career. These experiences and supports will be helpful for Cynthia to be successful in a science major in college. As a high school science teacher I hope discussing information about factors for success in science in college with Cynthia and other students will raise their awareness and assist them in their future studies.

It is meaningful for me to reflect on my own science identity while learning about what influences my students’ identities and determining how I can best support their interests. Cynthia and I both love learning about science. In our cogens I would regularly ask Cynthia what she liked about science and what she wants to do when she “grows up.” I explained to Cynthia that when I was in high school I didn’t know what career I wanted to pursue but I loved biology and ecology and majored in biology in college and minored in marine science. My main interests in science are about nature and ecology stemming from my summer childhood experiences spent almost entirely outdoors at my family’s cottage on a lake in Northern Ontario. In college I enjoyed most of my science courses but I struggled in my Organic Chemistry classes. I especially enjoyed my Marine Invertebrate Zoology class, where we took multiple field trips to collect specimens at beaches and salt marshes in the local area. I also had the opportunity to study abroad for a semester in Australia, where I took a Marine Ecology course that had a multiple day field excursion at a marine nature preserve. One summer I was an intern for a professor who observed and recorded sound and behavioral data of Beluga and Orca whales in captivity at a marine amusement park. My undergraduate senior research project involved monitoring water quality of a salt marsh. My interests toward Marine Science were encouraged through these experiences and I began thinking about pursuing a graduate degree in Marine Biology.
During my senior year of college I had an internship at an outdoor and marine education nonprofit organization, where I taught afterschool programs and led field trips to local natural areas for elementary and middle school students. I really enjoyed teaching in the outdoor setting, where I could share my passion for nature with my students. This experience influenced me to become a high school science teacher instead of pursuing a graduate degree in the sciences. Another reason why I entered teaching was because I was afraid of entering a graduate program and being in school for another four years before getting a job. The graduate school programs in education were much shorter. Additionally, I thought teaching would be a good career to have as a future mother because I would have similar hours as my children and would be able to enjoy the school breaks and summers with my family. My parents are both teachers, and I was accustomed to the idea of having this extra family time. I have had many positive science experiences inside and outside of the classroom in my childhood, adolescence, and adult life that have contributed to my science identity. Since our identities are fluid, it is important for me to reflect on my past experiences in science to position myself, and relate my experiences to my students.

I enjoyed sharing my experiences about becoming a science teacher with Cynthia. Although Cynthia may not feel that my experiences are entirely relevant to her life, I think it was beneficial for her to hear how I navigated college and learned the process of becoming a science teacher. Students often tell me they want to be a doctor, or a lawyer, or in Cynthia’s case a marine biologist, but they don’t know the steps required to reach their career goals. Our discussions in cogens gave Cynthia and me an opportunity to discuss the steps involved in becoming a marine biologist and give her a “roadmap” with potential routes to take to reach her goals.
Intersections of Race, Gender, and STEM

One of the laboratory classrooms at BASE is a large space that contains three large lab tables with the lab bench spaces radiating out in three spokes. Each lab table has gas supplies and each has a central sink. There is a mishmash of lab stools and chairs around the lab benches and many of them are broken. The wooden drawers for storage in the lab benches are mostly broken or missing, and serve as trash bins for food wrappers and old drink containers. The sinks also contain empty candy and chip wrappers and crumpled up papers. At the front of the room there is a large lab demonstration bench with another sink and a broken yellow eyewash flush safety apparatus. There is a large sliding chalkboard that no longer slides and is propped up on an old textbook. A missing a piece of the green chalkboard surface exposes big blotches of brown glue on the wall that look like human feces. There is old, broken furniture and office equipment stacked up in one corner of the classroom. One of the windows opens and closes properly. One of the windows doesn’t open at all. One of them opens but doesn’t stay open, so it is held open with a textbook. One window opens up all the way, without the safety blocks, making it feasible for a student to fall out. Most of the window shades are broken. In the warmer months the classroom gets too hot. In the colder months the classroom also gets too hot because the boiler in the school is turned way up to make sure that the following year the school gets the same amount of oil. There are some bulletin boards displaying posters of laboratory rules and old examples of student work. Overall, the classroom space does not look like an inviting place for teaching and learning. This classroom was overlooked by the construction crew when the building was remodeled, before the small schools opened. It has not yet been fixed.

At the beginning of each school year I would pray that the programmer didn’t schedule my classes for this space. Typically my science research class would meet in this space twice a
week, and sometimes my Field Studies class would gather here before leaving for the park or
garden. I never felt “ownership” for this classroom space. I felt it was the “Chemistry in the
Community” teacher’s classroom. (The Chemistry in the Community class is a watered-down
version of Chemistry for students with low math scores to take before they take Regents
Chemistry. It is mostly composed of low performing students and students with behavioral
issues.) I dislike teaching in this classroom because even my most respectful students don’t
respect this space. Why should they? It looks like a dump. Students notice the “junky” feel to the
room and don’t respect the classroom. Classroom management is especially difficult because of
the layout of the room, and the two entrances. Yet, room 507 is still not fixed after my seven
years of working at the school. I never asked to have it fixed. I just accepted it for what it is.

From a Critical Race Theory perspective, inequalities are perpetuated in American
society by white hegemonic structures. As I reflect on my teaching and learning experiences with
a lens of whiteness, I am left questioning my inaction to fix this learning space for my students.
The only attempt to “clean up” the classroom was by one of our former Assistant Principals who
moved the broken furniture to the schools’ basement and washed out the lab bench drawers. Why
did I, a white teacher, and the other teachers who worked in this space, just accept that this was
how the classroom was, and not fight to improve the physical conditions where students were
learning? Why did students not question me about this? Why did parents not have anything to
say, especially when some parent-teacher conferences were held in this room? Why did I not
challenge our school principal, and why was this inadequate learning space not a focus of
concern for her? We were all accepting this “junky” classroom and felt powerless towards fixing
it.
Admittedly, it was not high on my list of priorities to fix room 507 since I was already overwhelmed with my own teaching schedule, and I only taught in this space a few times a week. Perhaps my colleagues and principal felt the same way. The school budget was continually being cut, however this classroom was supposed to be remodeled by the school construction board before the school even opened and for whatever reason it never happened. It is totally unacceptable that my students were subjected to these “grungy” learning conditions. I cannot see this classroom going unfixed for so long in the suburban high school where I did my student teaching. I guarantee that in the predominately white suburban school, parents, teachers, students, or administrators would have done something to fix up the physical space of the classroom. Why did this not happen in the urban setting of BASE? My only explanation for my personal inaction is that it was a lowering of my expectations of what my students deserved. I didn’t want to take the time or energy to advocate for myself or my students for better teaching and learning conditions. This is hard for me to admit because I also claim that I care about my students and hold high expectations for them. Unfortunately, I didn’t respect my students’ learning space enough to make an effort to get this room remodeled. I didn’t even think to start this process while working at BASE. After reflecting from a lens of whiteness I see this as a pronounced example of inequality that my students of color faced in the urban school setting and how I was helping to perpetuate this disadvantage with my complacency. This research experience has been a transformative endeavor for me, as discussions with Cynthia made me reflect on my own experiences with race and gender in science. This initial research contributes to science teaching and learning because it elucidates the experiences of two women in STEM at different stages in life at the intersectionality of race, gender and STEM. With the critical race lens of whiteness, it explores those aspects of race and privilege from a perspective that is not
often used, yet is critical in understanding race relations and inequities that exist in STEM education. In the US, the majority of teachers are white (US Department of Education, 2012) and in the increasingly multicultural urban communities where we teach, it is essential for teachers to relate to their students and learn about their students’ views in order for effective and equitable teaching.

Reflecting on my inexperience with diversity or race relations upon entering the urban science classroom, I must question why my teacher education did not better prepare me for such situations. Teacher educators should be aware of the variety of settings new teachers could encounter and work to better prepare new teachers for diverse settings. Individual schools could encourage more diversity training specific to the demographics of that location to help new teachers learn the cultures of their students. Addressing race relations in a teacher education program or an in-service training could also help teachers understand race related issues that may arise in the classroom and help teachers like me become more aware of their whiteness as they see the disparities between races in America. Learning to listen to my students in cogens was also very helpful for understanding students’ cultural identities and their experiences in the classroom. I encourage teacher educators to share this methodology with pre-service and in-service teachers. Teaching is a reflective practice, and researchers and educators must be inspired to more critically reflect on issues of race and gender in their lives, and where it intersects with their STEM classrooms and research contexts.

This research contributes to the body of literature around women of color in STEM from a critical race lens of whiteness and addresses what should be a growing body of research around issues of whiteness and STEM especially if the overarching goal is to encourage a diverse pool of students to pursue STEM majors and enter the STEM workforce. I learned from Cynthia that
she has more challenges being a woman of color pursuing science than I ever faced. In order to encourage students to enter the sciences, they need opportunities to express their science identities. Cynthia is an example of a student who took advantage of the opportunities provided through the school, such as participating in the Young Naturalists Club and taking the science research class. Participating in these science fields of culture enhances Cynthia’s science identity and increases the likelihood that she will continue in the sciences. All students should have opportunities to engage in science fields of culture to determine if they want to pursue science. Teachers need to be aware of the challenges women of color encounter upon entering a science profession in order to prepare students for these situations and work to eliminate the prejudices against women of color. White teachers need to be aware of their whiteness before they can work to overturn the prejudiced systems in American society.
My overarching question for this research was how are students’ science identities transformed through place-based environmental science teaching and learning? When I began this research with an emergent design (Charmaz, 2005) I did not expect it to lead me to learn so much about myself. I especially did not expect to investigate “uncomfortable” ideas of racial stereotypes and whiteness. However, just as I have experienced how teaching and learning go hand in hand, so too do researching my students’ identities and reflecting on my own identities. I use the term “identities” because within a sociocultural view of identity we have multiple identities that are continually changing, or transforming, as we interact with other people to reach individual and collective goals (Stetsenko, 2008). As Cynthia, my Caribbean American student, described her experiences with race and stereotypes I became reflexive about my experiences as a white woman both in society, in science, and in the classroom. In recognizing my own subjectivity to research and that the lens I bring to the context influences how I interpret data (Kincheloe & McLaren, 2008), I began this research wanting to confirm the benefits of place-based science curricula in an urban setting and its potential for increasing students’ interest in science by engaging students in authentic science research projects. I looked for themes of transforming identities to address this inquiry. I describe science learning, shifting stereotypes of scientists, connections between lifeworlds and science, and expanding senses of place, as evidence of identity transformation. Although contradictions exist in all patterns of coherence, my findings support the claim that place-based science education allows for identity transformation and I have developed several other key claims from this research.

My other key claims from this research highlight the necessity of being open to learning from my students about their lifeworlds and current senses of places. Sense of place refers to an
individual’s understandings of a place that are always interacting with the place to give the place meaning (Lim & Calabrese Barton, 2010). As I understand my students better, I can create more meaningful place-based science education lessons. Place-based science lessons incorporate the local environment into real world hands on learning experiences (Semken, 2005). I found that cogenerative dialogues (cogens) (Tobin, et al, 2005), the main methodology used in this research, were most useful in creating a social space for discussion and reflexivity with my students. I also claim that teacher education programs are often unable to prepare future educators for the diverse settings where they will be teaching since every class has its own unique individuals and dynamics. Therefore, cogens can be utilized by new teachers, such as myself, to help teachers reflect on and adjust to the cultures of their new settings. For example, I used cogens to reflect and learn about race and gender. Additionally, I found that community collaborations, such as the collaboration between Brooklyn Academy of Science and the Environment (BASE) with Prospect Park Alliance (PPA), Brooklyn Botanic Garden (BBG), and Brooklyn College, make place-based curricula like the BASE Field Studies class and the week-long geoscience program at Prospect Park possible for urban students. I claim that through participation in place-based science research projects, where high school students collect their own data in their local environment, and work in collaboration with college faculty, students feel like scientists and support their science identities. For these reasons I urge that community collaborations continue, and expand, to support as many urban students as possible. I will further discuss my key claims in this final chapter.

**Authenticity Criteria**

According to Guba and Lincoln (1989), research should have ontological, educative, catalytic and tactical authenticity. Ontological authenticity is when the members of the research
develop a more sophisticated understanding of the phenomenon being studied. The overall phenomenon studied in this research was identity transformation. I include myself as a “member” in this research because I am a participant observer. I recognize that my research is infused with my own beliefs (Kincheloe & McLaren, 2008). Educative authenticity means the research should be shown to have helped the members appreciate the viewpoints of people other than themselves. Catalytic authenticity refers to how the research should stimulate some form of action. Finally, tactical authenticity is reached if members are empowered to act as a result of the research.

Ontological authenticity was demonstrated in my research in Chapter 2 because student researchers and I reflected on our Field Studies experiences and learned about our identities. In Chapter 3, about the geoscience program in Prospect Park, ontological authenticity was met because students learned data collection methods for various geoscience projects while researching with undergraduate students and geoscience college faculty. Additionally, in Chapter 4, through my discussions about race and gender in science with Cynthia, my changing understanding of whiteness shows learning resulting from this research. Identity transformation is a result of learning and therefore this research meets the criteria for ontological authenticity.

The cogens used in my research provided space for educative authenticity because student researchers and I listened to each other and saw the perspective of others. For example, in Chapter 4, as Cynthia described her experiences to me about facing stereotypes because of her race and gender, I was able to see her view of societal structures. I would not have had this perspective, nor would I have considered my racialized self, if it were not for this research. Members appreciating the viewpoints of others demonstrated educative authenticity.
Catalytic authenticity and tactical authenticity were reached in Chapter 2 by incorporating student feedback to revise and improve the Field Studies curriculum based on student responses in the cogens. For example, in one of our lessons about street trees, students determined the health of street trees in a neighborhood bordering the park, mapped the locations of the trees, and recorded their observations in a data table. This lesson was designed to teach students that we live in an urban forest and outside of the park we are still interacting with nature. One student said she didn’t like the lesson because “the class wasn’t into it” but it was “OK because I learned the trees I see regularly”. Although this student didn’t like the street tree activity she valued learning the names of the trees and indications of their health as it added a layer of science knowledge to her understanding of the local community. This student’s science identity was engaged and her sense of place developed as she learned how to identify local flora. Other students in the cogen described that they didn’t feel safe in the neighborhood where we were doing the street trees lesson. Students were uncomfortable when in an unfamiliar place that had a reputation of being dangerous. This feedback about the curriculum was taken into account and lessons were revised for the following school year by moving the location of the lesson to the neighborhood directly around the high school. Students were more familiar with this location even if they didn’t live in that neighborhood since they walked there to get to and from school. This example demonstrates catalytic and tactical authenticity because the Field Studies teachers and I were able to make changes in the curriculum based on students’ feedback in cogens.

Catalytic and tactical authenticity were met in Chapter 3 because students reported their findings from their authentic geoscience research projects to the Prospect Park Landscape Management Department so that records could be updated and plans could be made based on their recommendations. For example, students recommended areas for increased circulation of
the man-made water system to prevent anoxic conditions found in the sediment. Students reported that they felt like scientists during the place-based geoscience program and I hope that this experience will empower them to play a role in the science community in the future. Perhaps by entering a STEM major in college. However, I have not followed students from this research to see what college majors they enter.

In Chapter 4, catalytic and tactical authenticity were attained through my continued cogens with Cynthia, and my encouragement for other teachers to use cogens with their classes. Cynthia’s continued pursuit of a science career and maintaining her interest in science are also examples of how this research encouraged and empowered her, meeting the criteria for tactical authenticity. Future outcomes of this research that would further support catalytic and tactical authenticity, which have not yet been determined, would be to follow students through their college experiences to see if they enter STEM majors and careers as a result of their experiences with place-based science teaching and learning. Also, it would be interesting to determine if future catalytic authenticity is reached from other BASE student researchers and teachers using cogens to understand diversity and improve the teaching and learning in their classrooms.

Key Claims

The predominant theme of this research was to understand how individuals’ science identities are transformed in place-based science teaching and learning. In this empirical research study I have gathered evidence to support my claims about how I have observed this ongoing process with my student researchers and myself. However, within each of my claims there exist contradictions. Much can be learned from the contradictions to a claim and I do not mean that these findings reported here will hold true in other situations or should be generalized to other settings. Yet, I share what I have observed through my experiences so that other teachers,
informal educators, school administrators, and researchers can learn from and make applications to their contexts. One of my findings is that through a place-based education approach, students were able to collect their own data in the field and experience how science is practiced in the “real world.” A resounding theme was that students “felt like scientists” when they collected their own data. These learning experiences afforded transformation of science identities.

When students realized that much science happens outside of the laboratory, it changed their stereotypes of who scientists are and what scientists do. As we saw in the “draw a scientist” activity in Chapter 4, students’ images of scientists change from the stereotypical “Einstein” in a chemistry lab illustrated in September, to a range of illustrations when students drew their “scientist” in June. For example, Cynthia’s first drawing of a woman in a lab coat and her second drawing of a woman dressed in jeans, researching in the rainforest, shows how her concept of who a scientist is and what she does was transformed. However, not all students’ concepts of scientists changed throughout the school year. Many still drew the same stereotypical images of white men in their drawings in June demonstrating the difficulty of overturning some students’ engrained perceptions of scientists. This expanding perspective of science and scientists demonstrated by Cynthia’s drawings was also empowering for students like Nicholas. Nicholas’s science identity transformed through both his successful participation in the science fair and in our cogens. He expressed his increased confidence by speaking up and sharing about his research experience, something that he usually did not do in class. Both the place-based experiences and participation in the cogens were transformative science experiences for my students.

Additional evidence in my research that supports how science identities were transformed through place-based curricula was observed when students participated in science learning about their local environment, they made connections between their lifeworlds, or identities, and
science. While it is possible to connect students’ life experiences in the science curriculum in a traditional science class, place-based science lessons such as those described in this research, provided more of an opportunity to engage in real-world science. It would be difficult to make connections to all students’ lifeworlds at the same time with the same science lesson, regardless of the location or lesson topic. Therefore, for some students, the place-based lessons might not have fostered any connections to student’s life experiences. Students who did make connections between the place-based science experiences and their lifeworlds connected the place-based science experiences to their prior experiences and memories of picnics or sporting events in Prospect Park, and to memories of other places. For example, two students compared finding a slug during a lesson on decomposition in Prospect Park to their prior experiences with frogs in Guyana, or in Upstate New York. Another connection I described in this research was when, during a lesson about plant adaptations at BBG, one of my students saw a banana tree and happily shared how he remembered these trees growing “at home,” with home referring to his country of identity and origin in the Caribbean. Forging connections between my students’ lifeworlds, or other aspects of their identities, and science, while recognizing their ways of knowing, added value to the science we learned and helped students see how science could be useful in their lives, thus expanding particular students’ notions of science, and again, potentially transforming their science identities.

Since sense of place is determined by an individual’s memories and experiences of a place, and how they connect to one’s identity, we all experience places in our own unique way (Adams, 2013). More evidence of transforming science identities emerged when my students and I participated in science lessons in locations at Prospect Park and BBG. Through these activities our sense of place of these locations expanded. For example, students came to see ways that
humans impact on the park, such as the inability of grass to grow in areas where people
compacted the soil by walking on the grass instead of the designated paths. Students studied the
“science” behind why certain areas of the field in the park were bare of grass and why some were
roped off for plants to regrow. This was a different perspective for students to think about the
park and students viewed how their actions and the actions of others could negatively and
positively affect the park’s ecosystem. Conducting science lessons in the park and garden made
us see these places differently. I felt it was important to strengthen students’ connections to these
places to increase their appreciation, sense of care, and stewardship for the environment because
of my own sense of place and appreciation for natural places. My sense of place expanded as I
began to view Prospect Park, BBG, and the area surrounding the school, as alternative science
classrooms and thinking of all of the possible science lessons to hold in these places.

Alexia and Kim’s photographs of Prospect Park (Chapter 2) present examples of my
students’ expanding sense of place. Alexia took photographs of the science investigations that
she and her group engaged in during Field Studies. Alexia described in cogens that she wanted to
show the process of their project to document what science topics could be studied in Prospect
Park. Alexia’s sense of place of the park expanded to view the park as a place for learning about
the local ecosystem. Kim’s sense of place is also depicted in her photographs of Prospect Park.
Kim said she wanted to capture the natural beauty of the park and expressed her aesthetic
appreciation for nature through her photographs. In my first interpretation as a science teacher I
was glad to see that Kim appreciated the natural environment, which is one of my teaching goals,
but I did not see how her photographs depicted science. Upon sharing my initial findings with
the greater community of sociocultural science education researchers, I was led to consider the
concept of “re-seeing” (Girod, 2007). I am grateful for the opportunity to participating in a
community of researchers to see new lenses of my research. Re-seeing Kim’s photographs made me appreciate their aesthetic qualities, while noticing the scientific concepts that were represented. In our cogen reflections about Kim’s photographs we focused on appreciating Prospect Park as an oasis of nature in the urban environment, which still functioned to expand our sense of place by increasing our appreciation for nature as we saw the park’s environment in different ways. I chose to report on Alexia and Kim’s photographs in this dissertation because these two student researchers took multiple photographs over consecutive weeks, whereas other student researchers did not have as large a data source. I also chose these photographs because these student researchers had quite different ways of capturing their science experiences. Where Alexia took pictures of science activities and results of the experiments being performed, and Kim took pictures of science’s natural beauty. I would like to further investigate the connections between art and science in the future and to understand how art, in the form of photography, is an expression of students’ identities.

My second key claim is that through cogens teachers can learn more about their students and design more meaningful place-based teaching and learning experiences. Cogens provided the space for me to listen to my students and reflect on the learning experiences in the Field Studies classes. Since the Field Studies curriculum was co-planned by a team of educators from the school and informal partners, we were able to modify the place-based curriculum based on student feedback. Place-based teaching and learning is intended to provide learning experiences that are linked to students’ lifeworlds by situating learning in the local environment (Gruenewald, 2003). Because individuals experience places in unique ways (van Eijck & Roth, 2010), I don’t claim that each Field Studies lesson interested or inspired every student in the same manner. However, by listening to student feedback during our cogens I was able to share
students’ suggestions with my colleagues and make modifications for future learning experiences. For example the changes made to the street trees lesson were based on students’ suggestions. The Field Studies teachers and I wanted students to understand how to identify and assess the health of street trees in an urban ecosystem. Originally we chose the location for the lesson out of convenience because it was near the entrance to the park. Student researchers informed me in our cogen that the neighborhood was unfamiliar to them and that they were uncomfortable walking around the area where we were identifying trees. The following year teachers and I modified the location of the lesson to incorporate the area surrounding the high school building, which was a more familiar place for all students, and changed the required observations. Through holding science class in an area that was more familiar to students, the science learning connected to their existing identities and added a new science-rich layer of knowledge about a place that is familiar to them. Therefore a familiar community now also becomes a place of science learning and more likely affords experiences that build science related identities.

It is important that the Field Studies curriculum is examined from the standpoints of different stakeholders in the community, such as co-teachers, the education directors at the park and botanical garden, school administrators, and most importantly, students, so that the multiple perspectives of place, through our different lived experiences, are shared and incorporated in the class. Place-based education needs to recognize the different roles and lived experiences that curriculum designers hold and create spaces for other voices to participate in curriculum planning such as the planning meetings for the geoscience program and the input from students for the Field Studies class (Coughlin & Kirch, 2010). According to Olesen (2008) standpoint theory infers that knowledge is socially located and those who are of non-dominant cultures are
better situated for seeking knowledge about their own standpoints and the standpoints of those of
the dominant culture. Meaning, the oppressed can see their position and at the same time they
have to navigate the “other”, dominant world. Having to navigate both places provides
individuals with a broader perspective of the system. It is necessary to include the voices of the
non-dominant culture in research. In the case of education research, students are often viewed as
being in the non-dominant position. Individuals’ standpoints and opinions, including those of
researchers, change depending on their exact point and perspective at a given time. Therefore
examining the Field Studies curriculum from different standpoints helps to improve the program.

My third key claim is that my teacher education did not prepare me for the diverse urban
setting where I began teaching. In our cogens my student Cynthia raised issues of race and
gender that I did not know how to address. As a young woman of color, Cynthia will face the
double-bind (Ong et al, 2010) entering the field of science—having two underrepresented
identities. Cynthia told me about her current challenges of being stereotyped, and future
challenges she will face, and I did not have an explanation for her as to why our social world
created barriers for her because of her identity. I have always had an open mind towards
diversity, but I had never faced my own feelings about my racial identity, which is framed as
whiteness in critical race theory (Frankenberg, 1993), and what that meant for me as a white
female teacher in a school predominantly of students of color. I was able to explore my own
gender and racial identities while learning about Cynthia’s identities in one on one cogens. This
caused me to reflect on my own teacher education and realize that it did not adequately prepare
me for the issues of race that I faced in the classroom setting. Through the case study of Cynthia
I learned how my “original” white identity disadvantaged my students because I did not address
racial inequalities in my teaching. Because of differences in my lived experiences from that of
my students, I had difficulty relating science learning to my students’ lives. The cogen structure provided the necessary forum for my continued learning of “other” cultural identities and forced me to reflect on my own “otherness” vis-à-vis my students of color. I believe that teaching and learning in my classes improved as I recognized our differences and, instead of ignoring racial issues, I began to discuss them with my students and other teachers. Raising awareness is a first step for ameliorating racial disparities. I recommend that other white teachers and pre-service teachers learn about their white identities and a critical race framework through coursework, self-reflection and shared discussions in order to better relate to all students.

My fourth key claim is that community collaborations have the potential to afford stronger place-based education programs. The current structure of the BASE Field Studies program is possible because of the resources provided by the partnership PPA and BBG. Without the additional teaching staff and supervision provided by these organizations the Field Studies class would not be possible. Community collaborations, such as the collaboration between BASE and Brooklyn College in the informal science program in Prospect Park, created the opportunity for students to conduct science research projects with scientists from the college. Completing authentic science research with scientists was a powerful identity shaping experience for most students and most all student researchers responded in their surveys that they felt like scientists as a result of their participation. Through participating in this community of practice (Lave & Wegner, 1991), many students’ science identities expanded because they played a role (Stetsenko, 2008) and felt they belonged in the science community.

**Shifting Perceptions of “Research”**

One of the ways that this research process has been transformative for me is in my approach to “research”. My undergraduate degree is in biology and this afforded me a very
positivistic view of science research before I began teaching. Initially, when I switched from the natural sciences to social sciences, I found most educational research to be “soft”. I considered social science to be a “soft” science because I felt it did not have “hard” data like what I thought was evidenced in science fields such as biology, chemistry, physics and geoscience. Meaning, I thought it was not truly “scientific”, and in my opinion the results weren’t reliable. This was before I came to an understanding that all science research is subjective. I had a paradigm shift when I began teaching. I recognized that my students are individuals. I felt that survey research, and research studies, and standardized tests that were based on large sample sizes, where results were generalized to an entire population, were not getting at what was actually happening with teaching and learning. I felt that when researching people, it was better to work in smaller groups or on an individual basis, learning in detail about specific cases. As an educational researcher I did not want to generalize results or look for “abstract universals” (Erickson, 1986) arrived at by statistical generalizations from a sample to a population. I agreed with Erickson (1986) and Lincoln and Guba (1985), that transferability was possible by studying a specific case in great detail and comparing it to other cases studied, but large generalizations should not be made. Therefore, qualitative research can be generalized to some extent (Eisenhart, 2008), but more importantly, I felt that learning about special cases was important for understanding variations and possibilities that exist.

At this same time I also came to an awareness that researchers are not truly able to separate their own selves from their research, and therefore research generally is biased in some way or another. When studying in the natural sciences I believed that researchers were objective in their work. However, as I began my own research in education, I noticed how my inquiries were based on my own life experiences and interests, and that it was not possible for me to
separate my ideas from what I was observing in my research. As my views of educational research shifted to ethnographic methods I endeavored to use hermeneutic phenomenological methodologies such as auto/ethnography and cogenerative dialogues to learn about my students’ experiences, while reflecting on my own experiences. I wanted to enact change to improve my teaching and learning to better reach my students who seemed very different from myself.

Chapter 3 of my dissertation was coauthored and underwent the peer review process and was published in an educational research journal. I explained above that I no longer adhere to a positivistic view of educational research. However, Chapter 3 includes statistical analyses of data gathered from pre and post surveys conducted with student researchers in the geoscience program. Through the peer review process my coauthors and I were asked to add that a limitation of our research was that we did not have a random sample of students complete the survey. We were also told that our research should not be termed “research”, because it was a short-term project and not an ongoing study. I do not think that having a representative sample is a limitation of the research, nor do I believe that a short term study should not be deemed research. Through the survey results and students’ science journal responses we were able to generate knowledge of student researcher’s reactions to participating in the program. However, in an effort to seek publication, my coauthors and I conceded to the journal editors’ wishes.

The main implication for teaching and learning that can be drawn from my research is that schools and community organizations should provide resources to engage students in meaningful place-based science education in order to connect science learning to students’ lifeworlds. The place-based lessons in the Field Studies class were held in locations outside of the school building allowing for students to collect their own data in the field, which proved to be a transformative science identity activity for students. The approach that BASE engaged in to
provide opportunities for place-based teaching and learning included forming the required Field Studies course for ninth grade students. The school administration scheduled blocks of time in the afternoon once a week for the course. Other resources required for outdoor place-based science included additional supervision of students on class trips. This requirement was met for BASE Field Studies by the partner organizations who provided salaries for the Field Studies educator and assistant. Other schools may not have similar support in place and will require chaperones from volunteers, parents, or school aides in order to plan data collection trips. Possibly schools could seek funding through grants, such as the spring break program in Prospect Park which was funded by a National Science Foundation grant awarded to Brooklyn College. Teachers could take the initiative to contact community organizations and meet with them to plan place-based learning activities. Or, community organizations could contact the schools to inform local teachers of the resources available. Schools and community organizations will also need to provide laboratory materials for science research projects. Investing in place-based science education will help connect students to their science learning and create transformative science identity development experiences.

I also learned from my study that when students work towards a public display of knowledge, in a PowerPoint or poster presentation, either by presenting to Prospect Park Landscape Management in the informal spring break science experience, or presenting Field Studies research projects in the BASE science fair, it is an expression of their science identities and allows their science identities to be confirmed by others. Presentations to the school and science community were a valuable assessment tool for determining student understanding. Therefore, I suggest that student presentations of place-based science research should be used more often as an alternative form of assessment of students’ science understanding, rather than
standardized tests. Gruenewald (2003) explains that place-based education can act as form of resistance to standardized curriculums because teaching and learning is situated in localized places. My research supports diversifying the science curriculum to address local science topics and I hope that other science educators and administrators consider the benefits of moving beyond the state-mandated science curricula for science teaching and learning.

Two suggestions for teacher education from this research are: to include training for planning place-based learning experiences, and to use dialogic methods, such as cogens, to engage students and teachers in reflections about teaching and learning. When I learned about place-based education as a graduate student it helped ground our environmental education lessons that the BASE teachers and the educators from PPA and BBG were planning in local places. We tried to make our lessons more meaningful for students by pointing out how we were learning about our own local place. Learning about place-based education theory also made me more receptive to students’ existing senses of place. This led to utilizing cogens to learn more about my students’ identities and their experiences in the Field Studies class in an effort to improve teaching and learning and make science learning relevant to my students’ lives. The cogens improved my teaching and learning and opened me up to ideas for understanding myself through the diversity of my students. Therefore this research implies that pre-service teacher education and in-service teacher professional development include the concepts of place-based education and cogens to improve teaching and learning in urban settings.

The recommendations for doing educational research drawn from my work include the inseparability of a researcher from their research, and the value of student researchers. My own perspective and learning is part of my research. I do not intend to be objective, nor do I think that other ethnographic researchers can accurately claim to be totally objective in their research.
(Kincheloe, 2004). Presenting my changing ontologies in my research of the Field Studies program and the case study of Cynthia are evidence of authenticity of the research. In my research on the informal science research program I am a participant observer and do not claim to be separable from the research. I also imply the great value of including student researchers in educational research. In my research, students participated in cogens and were not merely subjects of the research, but contributed to our research findings and learned educational theory alongside me. I imply that other educational researchers would have much success including their own reflections in their research and incorporating student researchers.

My work also holds implications for educational policy in that teachers should have opportunities to plan their own local place-based science curriculum. I also imply that “small schools” with themes, such as BASE, create teacher and administrator “buy-in” for programs specific to those schools, like the Field Studies classes. Small schools are more able to restructure themselves around their themes like how BASE is organized to provide an extended block of time for Field Studies once a week. This restructuring requires the support of school administrators and of course teachers.

From this research I point toward the benefits that the formal educational partnerships between BASE, BBG and PPA, and the informal partnership between BASE and Brooklyn College provide and suggest that they are models for other urban schools. Formal and informal partnerships with community organizations support BASE students and teachers by providing more science programs. The continued support through partnerships is necessary to provide programs such as the Field Studies class, the spring break geoscience immersion program in Prospect Park, the Young Naturalists extracurricular club, internships, and opportunities to engage in authentic science research with scientists from the community. Since there are no
written contracts between BASE, BBG, and PPA, the partnership is at risk of being dissolved. BBG and PPA are under no contract to provide funding for programs for BASE. Unfortunately, since the time of this research, the funding for the PPA education department was drastically cut and PPA could no longer contribute to a full time Field Studies educator. BASE Field Studies teachers, the principal, and education department administrators met to determine how to restructure the Field Studies program with less coteaching and therefore fewer opportunities to teach out in the field. This put more strain on the BASE teachers, however, due to their commitment to outdoor place-based learning, and support from the school administration, the Field Studies program successfully continued. I don’t expect that the partnerships with BASE will ever dissolve, however if they did, even with the dedicated teaching staff who believe in place-based approaches to teaching and learning, it would be exceedingly difficult to plan as frequent place-based learning experiences for students at BBG and PPA. In this research urban students benefitted from the school’s partnerships with community organizations and I therefore recommend that such partnerships are encouraged.

Conclusions and Further Directions

The overarching question of how are students’ science identities influenced by place-based science teaching and learning was addressed in this research through cogens and students’ photographs in the Field Studies class, and also through the focus groups, surveys and science journals in the week long geoscience program. This question led to inquiries about stereotypes of race and gender in the sciences and to my reflection of my racialized self through a lens of whiteness. In this research I reflected on my own life experiences as I learned my students’ stories using hermeneutic phenomenology (van Manen, 1990) to surround our experiences with meaning. Through these inquiries my findings contribute to the bodies of knowledge of: science
identities, sense of place, place-based science education, whiteness, and formal and informal partnerships.

This research raises additional questions for urban science education. For example, it would be interesting to follow student researchers and students who participated in the geoscience program to see what they study in college, what career paths they take, and what their memories are of learning from a place-based perspective. Tracking students and following up with them several years after this initial research would demonstrate if there were any lasting impacts from participation in place-based science projects on their science identities. Other potential topics for future research include learning the perspective of the scientists and college faculty that implemented the week-long geoscience program to determine their thoughts about working with high school students. It would also be worthwhile to see if this research has any ripple effects at BASE. For example, possibly student researchers and other teachers could use cogens in their classes. This research is very case-specific and should not be applied directly in other settings. However, my hope is that this work will inspire other educators to implement their own place-based science units and conduct their own research with students using cogens.
APPENDIX A

High School Student Interest Survey

ID Code: ________

Thank you for your participation completing this survey. This survey will take about 20 minutes to complete. The information you provide will remain anonymous (you will be assigned a number for an ID code instead of writing your name on the survey).

- Please record your ID code on the informational letter from ________ at the top of this paper. Please ask if you don’t know your ID code or write your name on this paper.

- The purposes of this survey are to: determine students’ interests in science and the environment, and improve science learning experiences for high school students.

- Please return the completed survey to _____________________ High School by May 6th, 2011. Thank you for your time.

Directions #1-27: Circle the number of the response that best reflects your feelings about the following statements.

Directions #28-32: Please circle or write your response.

<table>
<thead>
<tr>
<th>1. I care about the environment.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. I would rather learn about science in the park than in the classroom at school.</td>
<td>1 2</td>
<td>3 4</td>
<td>5</td>
<td>6 7</td>
<td>8 9</td>
</tr>
<tr>
<td>3. I am interested in studying land formations and earthquakes.</td>
<td>1 2</td>
<td>3 4</td>
<td>5</td>
<td>6 7</td>
<td>8 9</td>
</tr>
<tr>
<td>4. I want to one day study science as a career.</td>
<td>1 2</td>
<td>3 4</td>
<td>5</td>
<td>6 7</td>
<td>8 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5. I have taken a science class that is/was held outside.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I learn from completing lab experiments.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. It upsets me when people litter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I plan to go to college.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I consider myself a scientist.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. It is my responsibility to take care of the environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I enjoy going to outdoor parks during nice weather.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I like science more when it is studying about an area where I live.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I value natural spaces, like parks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I would like to present a science project at a science fair.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I would like to study life sciences (for example biology) more than geosciences (for example earth science).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>16. I think high school students are able to work with college professors and researchers on science projects.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I like doing hands on activities (labs) in science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I enjoy learning outdoors.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. I have taken a science class that studies earth processes such as earthquakes and seasons.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. I like learning about how people impact the environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. I am considering majoring in science in college.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. I understand science better when it is related to my life.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. I am interested in studying global climate change.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. I enjoy my high school science classes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25. If I had the opportunity I would do a science project that would help my community.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26. I would rather identify animals and plants than identify</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
rocks and minerals.

27. I like spending time outdoors.

28. Please circle your gender: Male Female

29. Please circle your grade: 9 10 11 12

30. Please circle the ethnicity you most identify with:
   African American  Caribbean American  Black
   Latino/Latina  White  Asian
   Other if not listed above: __________

31. What is the first language you speak at home? __________

32. What are your parents’ highest levels of education and/ professional training?
   Mother: __________________
   Father: __________________

33. What is your definition of geoscience?
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

34. Describe one topic or research question a geoscientist might study.
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

35. Describe the benefits and drawbacks of working with college students and professors on science projects.
Please record your ID code on the informational letter from __________ at the beginning of the survey. If you don’t know your ID code, please record your name.

Please return the completed survey to _______________ High School by May 6, 2011.

Thank you for your time and participation in this survey.
REFERENCES


Adams, J., & Gupta, P. (2010). The continuum of participation in meaningful, purposeful out of school experiences mediating identity development as STEM learners, consumers and producers. [Whitepaper] *National Science Foundation Innovative Technology Experiences for Students and Teachers Convening*, Science Museum of Minnesota, Minneapolis, MN.


Alexakos, K., & Pierwola, A. (2013). Learning at the “boundaries”: radical listening, creationism, and learning from the “other”. *Cultural Studies of Science Education. 8*, 39–49.


National Science Foundation. Available at: http://www.nsf.gov/statistics/wmpd/

National Science Foundation Division of Science Resources Statistics. (2010). Characteristics of  
recent science and engineering graduates: 2006. Retrieved December 20, 2013, from  

Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics.  
Advancement in Health Science Education, 15, 625-632.

Olesen, V. L. (2008). Early millennial feminist qualitative research challenges and  
contours. In N. K. Denzin & Y. S. Lincoln (Eds.), The landscape of qualitative  
Publications.

W. M. Roth, & K. Tobin (Eds.), Science, learning, identity. (pp. 311-370). Rotterdam,  

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2010). Inside the double bind: A synthesis of  
empirical research on women of color in science, technology, engineering, and  
mathematics. White paper presented to The National Science Foundation. March 31,  
2010.

1994.

Behavioral Scientist, 40(2), 143+.

environmental responsibility and education. Netherlands: Springer.

Powell, W. et al. (2009). Place-based initiatives for urban students of introductory geoscience  
courses in Brooklyn. GSA Annual Meeting 2009. Portland, OR.


Stetsenko, A. (2008). From relational ontology to transformative activist stance on development
and learning: expanding Vygotsky’s (CHAT) project. Cultural Studies of Science Education, 3, 471-491.


