American Educational Research Journal
March 2008, Vol. 45, No. 1, pp. 68–103
DOI: 10.3102/0002831207308641

Creating Hybrid Spaces for Engaging School Science Among Urban Middle School Girls

Angela Calabrese Barton
Edna Tan
Michigan State University

Ann Rivet
Columbia University

The middle grades are a crucial time for girls in making decisions about how or if they want to follow science trajectories. In this article, the authors report on how urban middle school girls enact meaningful strategies of engagement in science class in their efforts to merge their social worlds with the worlds of school science and on the unsanctioned resources and identities they take up to do so. The authors argue that such merging science practices are generative both in terms of how they develop over time and in how they impact the science learning community of practice. They discuss the implications these findings have for current policy and practice surrounding gender equity in science education.

Keywords: case study, girls, identity, science education, urban

During a unit on "how nature provides us with food," the students in Mr. M.'s 6th-grade life science class were learning about decomposition, nutrient recycling, and organic matter. The students made a class compost box as part of the larger investigation into "how nature provides us with food." On the day when Mr. M. brought the red wiggler worms to class for the compost, he designed his lesson plan and management approaches to foster student participation while minimizing the number of disruptions he anticipated live worms would generate. For example, he had the students draw up a sense chart, which is a box with space for the five senses that they were to use to fill in their observations of the live worms before they were placed in the compost, a heuristic used frequently across the school year. He also made it clear by reminding the students of his rules several times that they could not roam about the classroom, yell, throw, or in any way disrespect the worms, or the activity would end. This was typical of Mr. M. While a very hands-on teacher, he was also a rather strict disciplinarian. He had real ability to keep student excitement up while keeping students on task. He was especially particular during this lesson because another class had made the compost bin just before, and it was rather chaotic with everyone walking around.

After distributing the worms, the class erupted into the expected squeals and groans. Students were picking up the worms, urging them to move on their tables or in their hands. Some students were commenting on how disgusting worms are, while others excitedly tried to figure out which end of the worm was which. Students also talked with one another about their observations. Statements like "The pointed part, it's the head I think" could be heard throughout the room.

In the middle of all of this, Amelia, a student whom Mr. M. had described during the first weeks of school as a "troublemaker" and a "weak" science student, was handling a worm that defecated, with the excrement falling onto her notebook.[1] Amelia appeared both disgusted and proud and shouted loudly, "Look! The worm pooped in my notebook! The worm pooped in my notebook!" She then left her seat with her notebook and ran toward the teacher who was standing at another table to show him the specimen. She shouted loudly to him, "Mr. M., *look* the worm *pooped* in my notebook!" She called to him a few times before he gave her his attention and said "Good Amelia, you are the only one with worm poop on your notebook. Circle it and write worm poop next to it." She circled the specimen with loud groans and called to her classmates to come look at her worm poop. She then got up again to walk around the room showing her worm poop to each of the groups in class while also socializing with her peers. Mr. M. did not stop her

---

ANGELA CALABRESE BARTON is an associate professor at Michigan State University in the College of Education, 329 Erickson Hall, East Lansing, MI 48823; e-mail: *acb@msu.edu*. Her research focuses on issues of equity and social justice in urban centers, with primary attention on understanding the learning experiences of low-income youth. Drawing primarily from feminist and sociocultural theories, she is deeply committed to researching with teachers and youth to build equitable and place-based learning environments and opportunities to gain access to and learn science in ways that support who youth are and want to be.

EDNA TAN is a postdoctoral fellow at Michigan State University in the College of Education, 326 Erickson Hall, East Lansing, MI 48823; e-mail: *tane@msu.edu*. Her research focuses on urban girls' identity development from feminist and sociocultural perspectives. Her work has grown out of her experiences teaching life science to urban girls and her efforts to design pedagogical practices that draw upon students' life worlds.

ANN RIVET is an assistant professor at Teachers College, Columbia University, 412 Main Hall, New York, NY 10027; e-mail: *rivet@exchange.tc.columbia.edu*. Her research grows out of her experiences in curriculum development. She draws from cognitive theory and is interested in how teachers and students learn to take up a reform-based science curriculum.

---

from taking these actions even though he had stated several times that students could not get out of their seats.

During a whole-class discussion of the worm observations that followed the group activity, Amelia was the central participant. She volunteered many of her observations, such as “They’re wet and slimy. . . . One’s 3½ inches long. . . . They smell like soil,” and Mr. M. repeatedly made reference to her worm poop as “nature’s way of recycling nutrients,” one of the main aims of the lesson.

Our attention was called to this event because Amelia was deeply engaged in making sense of worms and because her engagement seemed to be related not just to the worm observations themselves but to how she was able to negotiate a new kind of participation in class—indeed, a new kind of authority. Not only did Amelia manage to break Mr. M.’s participation rules successfully; instead of getting in trouble, which would be a typical outcome in this particular learning space, she was encouraged by the teacher and guided in extending her thinking.

Amelia’s worm poop was a precious commodity because it concretely illustrated many key terms Mr. M. wanted to bring across in that lesson. Yet, Amelia’s worm poop was also an important commodity because its value, as a science object, seemed to enable Amelia a greater degree of social freedom in the classroom, something that was important to Amelia on a daily basis. While Amelia used the worm excrement to move around the classroom, her conversation with peers easily shifted between the science of worm observations to social matters. By her words and actions, it appeared that Amelia was excited about her worm’s poop and took ownership over it. When recognized by the teacher, Amelia’s ownership over the worm poop served as an entry point for Amelia to more deeply engage in the activity, as can be seen by her seriousness in discussing her observations later in class that day.

We begin our article with this short vignette because it raises questions for us about how, when, and why girls take up science in school in ways that support who they are and who they want to be while at the same time pushing them along to become more central participants in their science learning communities. The questions that guide our research include the following:

- How do girls create new spaces for deeper engagement in science, and what do these spaces look like?
- What resources and ways of being do girls take up in science class to support their own deeper engagement in science?

These questions are important because they respond to recent calls for deeper, more rigorous, and longitudinal approaches for understanding how and why some girls pursue and succeed in science (National Academies, 2007). In an effort to answer these questions, we offer a framework of hybrid spaces in support of science engagement and its implications for policy and practice efforts to work toward “science for all.”

Background

Gender and Science Learning

Recently, it has been argued that the "problem" of girls and science, and in schooling more generally, has been solved (Conlin, 2003). For example, *Business Week*'s cover story in May 2003 (Conlin, 2003) reports that girls drop out of school less often and receive higher grades than boys. National trends reveal that the academic success of girls in most areas of science now equals or exceeds that of boys at the 8th- and 12th-grade levels (National Center for Education Statistics, 2004). Like others, we herald these advances for all girls in science. However, we are also deeply troubled by the continuing trends in girls' identification with and participation in science that receive scant notice. Despite relative equal achievement in science education, girls tend to not identify with science, and this impacts their movement along science trajectories (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Carlone, 2004). The problem grows in size the further girls progress along their potential science trajectory. In 2007, the National Academies reported that women who are interested in science and engineering careers are lost at every educational transition. Furthermore, the report continues, the problem is not simply the pipeline:

> Women are very likely to face discrimination in every field of science and engineering. . . . A substantial body of evidence establishes that most people—men and women—hold implicit biases. Decades of cognitive psychology research reveals that most of us carry prejudices of which we are unaware but that nonetheless play a large role in our evaluations of people and their work. An impressive body of controlled experimental studies and examination of decision-making processes in real life show that, on the average, people are less likely to hire a woman than a man with identical qualifications, are less likely to ascribe credit to a woman than to a man for identical accomplishments, and, when information is scarce, will far more often give the benefit of the doubt to a man than to a woman. (National Academies, 2007, p. 3)

While the National Academies report targets women in the academic science and engineering pipelines—from undergraduate education to university faculty—these concerns are relevant to youth in K-12 education. The past 15 years have revealed insights into the barriers girls face in their quest to express interest and participate in all of the science subject areas (American Association of University Women, 1999; Howes, 2002; Parker & Rennie, 2002; Reid, 2003; Sungur & Tekkaya, 2003). The barriers that girls face in engaging with and succeeding in school science range from school and societal attitudes that portray science as masculine and girls as incapable of meeting its challenges to a lack of equity-minded curricula, pedagogical strategies, and professional development tools.

Research in urban science education shows that girls living in high-poverty urban communities face additional barriers to equitable science education. In high-poverty urban schools in the United States, students lack access to rigorous and high-level science courses; science equipment; appropriate role models; and certified, qualified teachers (Oakes, 1990, 2000). Middle and elementary schools in high-poverty urban communities tend to be greatly impacted by curricular and pedagogical practices driven by high-stakes exams in mathematics and literacy, often leaving little time for science instruction (Tate, 2001). Youth in these schools are also more likely to bring to the classroom discursive practices and experiences not valued in high-stakes assessments and to face teachers who do not have the knowledge or skills to effectively bridge school knowledge with out-of-school ways of talking, knowing, and doing (Brickhouse & Potter, 2001; O. Lee & Fradd, 1998). However, we also know that African American girls from low-income urban communities are outperforming boys, and we want to know what might some of the reasons be for this trend (Lopez, 2003).

Middle school is an especially crucial time to examine how girls, like Amelia, take up science in the classroom in ways that matter to them and that allow them to merge their in- and out-of-school identities. Middle school is a time when girls' choices for peer groups, mentors, grades, and after-school programs play a pivotal role in the high school trajectories they pursue and in the support they seek to become and remain engaged in science (American Association of University Women, 1999; J. Lee, 2002; Malcolm, 1997; Orenstein, 1994). Middle school is also a time when girls' attitudes toward science and achievements in science drop precipitously (Atwater, Wiggins, & Gardner, 1995).

Yet, research is also needed that moves beyond girls as a homogeneous population and beyond achievement as the only marker of success. Our research is keenly focused on how cultural and socioeconomic contexts frame girls' science experiences. We have chosen to focus our efforts on urban girls who attend high-poverty schools, because we are particularly interested in those girls who have been most underrepresented in the sciences. Clear understandings in this area may lead to more powerful programs and pedagogies for supporting high-poverty urban girls in science.

Hybrid Spaces for Science Learning

Sociocultural studies in science education have taught us much about the culture of school science and how, for many youth, learning science is as much about becoming a legitimate participant in the science learning community as it is about learning the content of science (Aikenhead & Jegede, 1999; Seiler, Tobin, & Sokolic, 2003). For some authors (i.e., Aikenhead & Jegede, 1999), this process involves learning to cross borders between cultures, while for others, it is more about learning how to apply resources within new fields appropriately (Seiler et al., 2003). Despite these differences, these studies are grounded in the belief that the science classroom is its own subculture, with particular ways of knowing, talking, and doing that do not always clearly align with the social worlds that youth bring to learning science.

Aikenhead and Jegede (1999), among others (i.e., Varelas, Becker, Luster, & Wenzel, 2002), write about how learning to participate in the subculture of school science is often treated as a process of assimilation rather than enculturation. In this view, science instruction is at odds with students' worldviews, and successful science learning forces students to "abandon or marginalize their life world concepts and reconstruct in their place new scientific ways of conceptualizing" (Aikenhead & Jegede, 1999, p. 274). The challenge raised by this stance is to consider how science teaching and learning might look if students were to be supported in becoming fluent in the subculture of school science while not simultaneously abandoning their life worlds.

Some scholars have taken up hybridity theory to describe how teachers, students, and others in school settings establish new forms of participation that merge the first space of school science with the second space of the home to create a third space that has elements of both. This third space is described as a hybrid space because it brings together the different knowledges, discourses, and relationships one encounters in ways that collapse oppositional binaries, allowing them to work together to generate new knowledge, discourses, and identities (Moje et al., 2004). In conceptualizing the third space, Moje et al. (2004) draws from hybridity theory, which "posits that people in any given community draw on multiple resources or funds to make sense of the world" and that being "in-between several different funds of knowledge and Discourse can be productive and constraining in terms of one's literate, social, and cultural practices" (p. 42).

Moje et al. (2004) show that three different, although related, views on third space have been taken up in education research. One view defines the third space as a bridge between academic and traditionally marginalized knowledges and discourses (e.g., Gutiérrez, Baquedano-López, & Tajeda, 1999). A second view defines the third space as a navigational space, or a way of crossing and succeeding in different discourse communities (e.g., C. D. Lee, 1993; New London Group, 1996). Finally, the third space has been defined as a space of cultural, social, and epistemological change where competing knowledges and discourses challenge and reshape both academic and everyday knowledge (e.g., Moje, Collazo, Carrillo, & Marx, 2001). Moje argues that all three views are important contributions because they shed light on how youth cross borders in school settings, allowing them to maintain or build upon their knowledges and identities from outside of school while finding or creating ways to succeed within the school setting.

Similarly, Roth (2006) describes hybridity in terms of the "diasporic experiences" that youth bring to learning science. He argues that when confronted with differences, individuals continuously engage in what he refers to as "cultural bricolage," or "taking from here and there to make do," producing new, heterogeneous, hybrid knowledges and identities (p. 6). Roth speaks to how the lens of diaspora helps us to see how culture and identity are always heterogeneous—always a hybrid of practices. He argues that everyone enacts hybrid practices all of the time, but that some youth are marginalized because their hybrid practices are punished by symbolic violence—a kind of oppression brought about by the imposition of systems and meanings where only particular systems and meanings are granted legitimacy (Bourdieu, 1977).

It seems that whether one uses the lens of third space or diasporic experience, attention is called to how acts of creating hybrid spaces, discourses, and identities are always political and of the highest risk for those whose knowledge, discourse, and identities are positioned as lesser. The third space, or hybridity, therefore, sheds light on science learning because it offers a way of understanding how learning science is as much about learning to negotiate the multiple texts, discourses, and knowledges available within a community as it is about learning particular content and processes.

In our own work, we are interested in hybridity because we have observed time and time again youth taking up knowledges, resources, and identities in novel ways that often go unsanctioned by school science, changing how they participate in class. This allows them to build their social identities while they build and gain epistemic authority in the classroom. We have become curious about why and how girls engage in these diasporic experiences in ways that overcome what some might refer to as symbolic violence and in ways that reshape both academic science and the knowledges and discourses of youth's everyday lives. How youth, and in particular girls, do this and its meaning for girls' participation in science is something we return to directly in our analysis.

Practices and Identity

In our efforts to make sense of how youth participate in contributing to the third space in science class in support of their science learning, we draw upon the lenses of practice and identity. The idea of practice is grounded in sociocultural perspectives on learning (Lave & Wenger, 1991) and feminist and sociological perspectives on science education (i.e., Brickhouse, 2001). From this standpoint, learning science is an embodied activity. It is not just about what learners know but also how what they know is part of a larger system of activity, feeling, value, and performance. Learning science involves not only learning content but also learning how to participate in science-related communities.

The idea of science practices has begun to take on importance because it is one way of understanding science learning as an embodied activity. Common use of the phrase *science practices* tends to focus primarily on skills development. However, recent research into science practices has included how and why the deployment of such skills or ways of doing are situated within a social context. For example, Kelly and his colleagues (Kelly & Chen, 1999; Reveles, Cordova, & Kelly, 2004) describe science practices as those disciplinary-based practices that are involved in doing science and that are congruent with three dimensions of scientific literacy: investigative, communicative, and epistemic.

Tobin and his colleagues have also taken up the construct of practices but with deeper sociocultural intention (Seiler et al., 2003; Tobin, Elmesky, &

Seiler, 2005). In their work, practices have come to mean the act of appropriating forms of action or behavior in the classroom. These practices are often enacted without awareness and in accordance with the resources available.

The research conducted by Kelly, Tobin, and their colleagues is important, for it underscores how practices are social activities deeply connected to both content and context. What one is able to do in a setting is dialectically related to what one can access and activate in that setting, and that includes an understanding of content or of rules for participation. It also includes the individuals who are present as well as the physical environment. What these studies have not investigated explicitly, however, are the ways in which practices are implicated in identity construction or in creating new spaces for participation in a community of practice.

This is where the field of critical literacy studies and its focus on literacy practices has been quite helpful (Barton & Hamilton, 2000; Gee, 1996; Moje, 2000; Street, 1984, 2001). Literacy practices describe the ways in which individuals use literacy as a set of tools for specific purposes and within specific contexts. In these studies, literacy practices are situated and dynamic contributions from individuals, their social partners, and historical traditions and materials (Cole, 1995). They contain both structure and meaning and are also the basis for transformation in structure and meaning (Miller, 1995). For example, Moje (2000) has documented what literacy practices urban youth engage in (i.e., written practices such as tagging, body practices such as dress, and oral practices such as plays on language) and their purposes for doing so. More related to our point, Moje has focused on how literacy practices are tools for engaging in both sanctioned and unsanctioned activities to foster identity building and positionality within and across a variety of contexts.

Utilizing a critical literacy perspective, we extend current understandings of science practices to include not only how youth appropriate forms of action but also why youth appropriate science activity in meaningful ways in support of who they are and who they want to be. This view of science practices includes both what individuals do and the hows and whys such practices are employed.

Issues of identity—and how one positions oneself (or is positioned) through practice and identity building—are therefore central to making sense of science practices. In our practices framework, we align ourselves with those who view identity as fluid and constructed socially within communities of practice. Upon entering a community of practice such as the science classroom, students develop identities through engaging with the tasks of the science class. Learning science becomes "a process of coming to be, of forging identities in activity" or "identities-in-practice" (Lave & Wenger, 1991, p. 3).

The science classroom, as a community-of-practice, offers many different spaces where students can author identities, including whole-class settings, small-group work, and individual locations, among others. The identities-in-practice that are manifested when a student is asked to speak during a whole-class discussion may differ from those manifested when she is engaged in a small-group activity, and so on. A student may develop a repertoire of identities-in-practice from which she operates, depending on the nature of the space she finds herself in at any given time in the science classroom. For example, new opportunities to participate in different ways present themselves when a new topic that may interest the student is introduced, when a girl is partnered with a new small group from whom she can learn, or when the teacher assigns a project that allows the student to leverage on and showcase her unique skills and talents.

How students are positioned in the science classroom also shapes identity development. Students are positioned not only as novices but also as the "loud and dramatic girl," the "field-trip girl," or the "generous girl" based on their identities in other worlds that are brought to bear in science class. These positions imbue students with relative power and status in the science classroom. Official student positioning by the science teacher into roles such as group leader or group reporter also accords students power that can transform learning experiences and affect identity formation in science class.

Yet we know that, traditionally, girls are positioned with less power in the science classroom. They are called on less often to answer content questions and are not given as much attention as the boys by the teacher. As a result of this hidden curriculum, girls are led to believe that a scientific identity is antagonistic with their gendered identity (Sadker & Sadker, 1995). This further illustrates the importance of understanding how girls author their identities-in-practice while they learn. For example, Brickhouse and Potter (2001) show us how complex the relationship between identity and success in school and in peer groups can be for urban girls. Their work reveals that having a science-related identity does not mean that one will necessarily succeed in school, if that science-related identity does not also reflect the values of school-mediated engagement or if students do not have access to the resources they need to do science well. However, successful participation in school science, despite a lack of resources in the home environment, can be better facilitated when students have a science-related identity they can draw upon.

Understanding the relationship between identity and practice is important, for it suggests that we should be cognizant not only of the resources available to girls but also of how girls understand when and how to make use of these resources in support of who they are and want to be. By studying girls' science practices, we are able to see how girls make links between what they know and what they can do and how they choose to use their knowledge and skills in order to further their own goals in terms of science engagement. In other words, we believe that by studying science practices, we gain insight into how girls create hybrid spaces that support their efforts to craft new forms of participation and authority rather than render them subjects of symbolic violence in the science classroom.

Method

We draw upon ethnographic case studies conducted in three schools during the 2003–2005 school years. Longitudinal case study was employed because we believe it is well suited to take into account the contextual and relational nature of complex issues and processes and how these shift over time (Donmoyer, 1990; Yin, 1994). Case studies were conducted to allow us to (a) explore and describe girls' science practices, (b) document and describe how girls leverage those science practices to engage meaningfully in science, and (c) document girls' learning of key science concepts in the two content areas important in middle school: ecology and body systems.

We conducted our research in three New York City public schools: two middle schools, Grades 6–8 (The Inquiry School and Parkside School), and a K-6 school, where the 5th and 6th grades were treated as a middle school through separate scheduling and departmentalization (Hamilton School). All three schools were fairly similar in terms of demographic makeup, with roughly equal numbers of African American and Latino students and very small percentages of White or Asian students (see Table 1). All three schools had significant numbers of students qualifying for free- and reduced-lunch programs, and all of our partner teachers in these schools had between 3 and 6 years of teaching experience. The three schools were selected because they were all listed on the state's list of failing schools but were working hard to implement reform-based practices across the subject areas. Furthermore, they served similar student populations and were all neighborhood schools rather than selective- or competitive-entry schools. Finally, all three schools employed teachers who were willing to work with us on this project and were committed to reform-based teaching in science. We are three middle-class women science education researchers; two of us are White and one Chinese. We had gotten to know the teachers and schools in our previous work in the city through field-based work in preservice teacher education and collaborative action research among preservice and inservice teachers. We thus entered into this project with collaborative relationships already in place.

The science programs at all three schools drew upon reform-minded curricular materials with inquiry-based and standards-based approaches to teaching. In particular, all three schools predominantly used the LiFE (Linking Food and the Environment, a curriculum developed by the Center for Food and Environment at Teachers College, Columbia University, and published by the National Gardening Association) curriculum, in the fifth or sixth grade, with supplemental FOSS (a research-based science curriculum for grades K-8 developed at the Lawrence Hall of Science, University of California at Berkeley, and published by Delta Education) units. The LiFE curriculum focuses on teaching life science by exploring the relationship between food, humans, and local and global ecology. The LiFE curriculum capitalizes on the spiraling of scientific understandings as participants engage in learning, applying new and prior scientific understandings to hands-on activities and reinforcing theory and practice in everyday life through food.

We conducted year-long ethnographies in six classrooms across the two school years. In the 1st year of the study (2003–2004), in-depth case studies were conducted with 7 girls at Hamilton School (Mr. R.'s classroom). Then, during the 2004-2005 school year, we expanded our study to include 13 new

Table 1
Demographics of Participating Schools

School	Grades	Population	Ethnicity	Percentage Free or Reduced-Fee Lunch
The Inquiry School	6–8	450	45% African American; 55% Hispanic	90
Parkside	6–8	300	38% African American, 48% Hispanic students, 8% White, and 6% Asian	70
Hamilton	K–6	1,500 (450 in Grades 5–6)	50% African American; 45% Hispanic; 6% White	More than 95

case studies in the Inquiry (Mr. M.) and Parkside (Ms. K.) schools. During this 2nd year, we also extended the amount of time we spent in the two new schools to investigate girls' practices across more than one curricular unit. Case study girls were selected purposefully and collaboratively by the researchers and classroom teachers to reflect a range of interests and achievements in science as well as ethnic backgrounds. To construct the case studies, multiple sources of qualitative data were collected. These data included twice-a-week participant observations for 15 weeks at Hamilton and 31 weeks at The Inquiry School and Parkside, with accompanying field notes; two individual and group interviews lasting about 1 hour each per case study girl; one 45-minute content-based think-aloud focused on urban ecology; reflection notes; student work; and out-of-science-class and out-of-school informal conversations, observations, and hanging out (see Table 2).

Data were analyzed using a grounded theory approach (Glaser & Strauss, 1967; Strauss, 1987). Our data were coded primarily by the first two authors and discussed at weekly research meetings. If disagreement existed on the meaning or application of codes, we debated differences until we reached consensus. To uncover girls' science practices, we approached the data in two ways. First, we closely examined individual events where girls were actively appropriating a science activity in ways that seemed to support their engagement in science, even when that engagement may have taken forms different from what one might typically expect from a science class. Second, we traced the girls' participation in science class over time. What resources did the girls' activate, and how did they do so? How did their peers or teachers respond to them, and how did they respond in turn? How were their funds of knowledge and actions made public and incorporated to become part of the larger classroom discourse? This is consistent with the approach taken in critical literacy studies, where practice is viewed as not just what is done but what motivates it as well.

Table 2

Case Study Girls Data Table

School, Teacher	Case Study Student (ethnicity, socioeconomic status)	Participant Observation Field Notes	Videos	Think-Aloud	Interviews				
					Background	Views of Science	Favorite Work, After-School Discussion Group	Identity in Class	Progress in Science Class (student work, tests)
Inquiry School, Mr. M.	Amelia (Latina, low)	X	X	X	X	X	X	X	X
	Ginny (Latina, low)	X	X	X	X	X	X	X	X
	Jackie (Latina, low)	X	X	X	X	X	X	X	X
	Katherine (Latina, low)	X	X	X	X	X	X	–	X
	Melanie (Latina, low)	X	X	X	X	X	X	X	X
	Pat (Chinese/Latina, low)	X	X	X	X	X	X	X	X
	Trisha (Latina, low)	X	X	X	X	X	X	X	X
Parkside School, Ms. K.	Emily (Latina, low)	X	X	X	X	X	–	X	X
	Nayeli (Latina, low)	X	X	X	X	X	–	X	X
	Mari	X	X	X	X	X	–	X	X
	Shanti								

(continued)

Table 2 (continued)

School, Teacher	Case Study Student (ethnicity, socioeconomic status)	Participant Observation Field Notes	Videos	Think-Aloud	Interviews: Background	Interviews: Views of Science	Interviews: Favorite Work, After-School Discussion Group	Interviews: Identity in Class	Interviews: Progress in Science Class (student work, tests)
	(African American, low)	X	X	X	X	X	–	X	X
	Nicole (Latina, low)	X	X	X	X	X	–	X	X
	Dema (African American, low)	X	X	X	X	X	–	X	X
Hamilton School, Mr. R. and Ms. O.									
	Nini (Latina, low)	X	X	X	X	X	–	X	X
	Doranda (Latina, low)	X	X	X	X	X	–	–	X
	Crystal (Latina, low)	X	X	X	X	X	–	X	X
	Kimberly (Latina, low)	X	X	X	X	X	–	X	X
	Giselle (African American, low)	X	X	–	X	X	–	X	X
	Ginger (African American, low)	X	X	X	X	X	–	–	X
	Star (Latina, low)	X	X	X	X	X	–	–	X

Overlaying individual events upon longitudinal understandings of how the girls engaged in science across the school year as focal points in our analysis, we looked for patterns that mapped onto the girls and their participation in science class, to specific classroom contexts, and to pedagogical strategies. This overlaying of data allowed us to develop three interrelated coding trees that led to our findings. The first tree focused on developing nuanced understandings of the science events we observed in which girls noticeably shifted the discourse of the classroom community. We used this tree to foreground our understandings of individual and community changes. The second tree examined these events more closely to uncover the cycle of actions undertaken by the girls to support these changes. This tree uncovered the merging practices we discuss in this article. The third tree examined the resources accessed and activated by the girls as they engaged in these practices, with special attention paid to the tension between school-sanctioned and non-school-sanctioned resources. We were interested in who leveraged them and how this framed identity development. This tree helped us make connections between the practices we learned about and the girls' developing identities. Although each tree surfaced particular foci of data, all three worked in a complementary fashion to inform on the girls' contextually situated merging practices and identities.

Creating Hybrid Spaces for Science Engagement

The girls in our study creatively and flexibly created hybrid spaces for participation in science class. These spaces were marked by the novel recruitment of sanctioned and unsanctioned resources and identities. These hybrid spaces were sometimes formed in small-group work and sometimes within the space of the whole classroom. Nevertheless, these spaces were actively negotiated by the girls to allow themselves to engage deeply in science on their own terms while maintaining social status and relational authority among their peers. In what follows, we present descriptions of three practices that the girls in our study—across sites and curricular contexts—took up in ways that fostered the creation of hybrid spaces. We look at both the spaces created and how these spaces positioned the girls with new forms of authority and positionality in the science classroom. The merging practices we present here include creating signature science artifacts, playing with identity, and negotiating roles through strategic participation. We have identified other practices in the course of our investigation (i.e., storytelling, questioning), but choose to focus on these three because they capture a range of practices that youth might engage in. In presenting these practices, we draw upon three illustrative exemplars per practice in order to delve into the details of the practice and its meaning for the girls and their classroom communities. However, across our three sites, we have an extensive corpus of evidence to support our analyses regarding these practices (Calabrese Barton, 2007).

Signature Science Artifacts

The girls in our study engaged in the merging practice of making signature science artifacts that they strategically used to position themselves as legitimate participants in their science classrooms. We use the phrase *signature science artifacts* to highlight that the girls were involved in creating artifacts that were in many ways autobiographic in that these artifacts communicated who they were and wanted to be to their peers and their teacher. Yet, at the same time, the artifacts attended to and advanced the ways in which girls engaged the science ideas being explored in their classrooms.

While it is common for students to make artifacts in science class (i.e., graphical representations of data), we specifically refer to those instances in which the girls created artifacts that were neither assigned nor required by the teacher yet were produced by the girls in ways that contributed significantly to how they participated in science class. The artifacts the girls made ranged from intellectual artifacts, such as a song about bones, to physical artifacts, such as a rabbit magnet.

Take, for example, the bone song. During one of the concluding lessons on the skeletal system, the teacher instructed the students to make flash cards of the key terms describing the skeletal system in order to prepare for the end-of-unit test. Ginny, an outgoing and hardworking student, made her required stack of flashcards. Upon completing her flashcards, she also began to write a song about the skeletal system to the melody and lyrics of "Mambo #5" (a popular tune by Lou Bega) that she finished at home and brought to school the next day. During group study time, she shared the song with her peers, singing the lyrics and demonstrating the dance moves that showed off the bones and how they connected to each other. Ginny and her friends appeared to be very excited about her bone song and with encouragement from her peers sang the song to her teacher (Field notes, January 21, 2005).

Her teacher also appeared to enjoy the bone song, based on his encouraging comments to Ginny. He asked her for a copy of the song and that night typed it up and posted it on the board outside of his classroom. He also distributed copies to all students in his five sections of 6th-grade science.

Ginny's Bone Song

A little bit of cranium on my head
A little bit of mandible on my jaw
A little bit of scapula on my back
A little bit of humerus on this bone
A little bit of radius on the back
A little bit of ulna on the front
A little bit of carpals just like that
A little bit of meta carpals on my hand
A little bit of phalanges on the end
A little bit of tibia on the front

A little bit of fibia on the back
A little bit of torso just like that
A little bit of metatarsals on my foot
A little bit of phalanges on the end
Just wave your phalanges, yeah yeah yeah
Just wave your phalanges, yeah.

A little bit of patella on my knee
A little bit of maxilla beneath my nose
A little bit of clavicle on my shoulder
A little bit of vertebrate on the back of my spine
A little bit of sacrum on my hind
A little bit of pelvis on my hip
A little but of femur on my thigh
A little bit of patella on my knee
Just wave your phalanges yeah yeah yeah
Just wave your phalanges, yeah.

In Ginny's classroom, key terms and flash cards were a ritual practice. Ginny disrupted this practice by bringing in a nontraditional scientific resource (a pop song) to support her learning about the skeletal system. Ginny often sang and danced for fun during class breaks, and this was a strong part of her social identity (Field notes, October 22 and 28, 2004; November 12, 2004; January 21, 2005; February 14, 2005). The song was also more than a mnemonic device. Ginny creatively reworded "Mambo #5" and the key terms to pull together a song and dance that captured the configuration of the skeletal system. It is interesting to note that Ginny was highly successful on the skeletal system test, scoring 95%. Four months later when we interviewed her about her experiences in science, she could still perform the entire bone song and dance (see interview video at http://ed-web3.educ.msu.edu/CalabreseBarton/video.html).

The bone song also illustrates how signature science artifacts served as resources for entering into the science classroom discourse community with positions of authority without having to assimilate into the normative culture of the science classroom. Ginny could be a singer and dancer and invest these dimensions in her science learning in a way that positioned her as someone central to the classroom science community, as was evident in the role her song played in all five sections of 6th-grade science. With the bone song, Ginny's nontraditional resources for doing science were validated and integrated into the everyday talk of her classroom and 6th-grade science at her school.

In another example, Pat created a rabbit magnet as part of her animal project. The animal project was designed so that students could learn independent print- and Internet-based research skills. For the project, students had to select an animal, research it, and prepare a written report along with a poster summarizing their findings. Pat selected the snowshoe hare because, as she told us, “It was different,” and there was little available classroom information, allowing her to search the Internet for information. Pat had also told us in an interview that she wanted to attend an art-focused high school, and so it was not surprising when we observed her devoting a great deal of energy to designing her poster.

On the day the posters were due, Pat came to school with a poster and a homemade magnet of her rabbit. She explained to us that she wanted to make a “3-D sculpture” of the snowshoe hare using “Styrofoam and cloth,” drawing upon some skills she had learned in art class, instead of the two-dimensional drawing required for the poster. She also said that she transformed her sculpture into a “refrigerator magnet” when she could not get her sculpture to stand on its own.

Pat’s magnet was unique in many ways. Not only did she make a model that existed independently of the required poster board, but when it was her turn to give her animal poster presentation, she used her magnet to talk about the structure and function of snowshoe hares rather than read from her poster, as many of the other students did (Field notes, January 8, 2005).

In the whole-class discussion following the presentations, the teacher specifically singled out Pat’s magnet as an example of a model that offered scientific information in a way that was interesting and useful. He referred to her magnet several times in the class discussion. He also placed the magnet on the board at the front of the room and used it for the remainder of the school year to hold up student work (Field notes, February 3, 2004; June 17, 2004). The teacher also told the class that he would use the magnet as an “example of what the next batch of 6th-graders can do for their animal project.”

Pat was proud of her magnet and talked at length about it during the interview on her favorite piece of work several months after the experience:

Pat: Ok, so my favorite project is the animal research project. Because I really really believe that I went to my potential, because I made a magnet, with my hand, I made a poster board, I wrote a essay, it was, I don’t know, it made me feel really good inside.

Researcher: What do you mean it made you feel really good inside? Can you elaborate on that?

Pat: Like, I can’t explain the feeling, but it’s like a feeling, like you are, like it just lights up a part of you.

Researcher: Can you tell me why you decided on the snowshoe hare?

Pat: I forgot, like, some people think it’s a bunny, but its like. . . . Well, I wanted to do something that nobody has done, something different, because that’s just how my personality is. I just want to be myself, so I picked that because it is different.

Researcher: Ok, what do you like about your project? Why did you pick that out of all the work you’ve done?

Pat: Because, the other work, there’s mostly no evidence of . . . mostly no evidence that, that I did it, but everybody looks at that [animal] project and they go wow, look at that look at that. . . .

As the transcript indicates, this signature artifact offered Pat a space to merge her social identity with the world of her classroom in ways that deepened her confidence in science and offered other students potential inroads for doing the same. Moreover, while the magnet was a scientific model, it was also a functional tool for the classroom and a trinket, in the sense that it was a small, delightful object that was also displayed for its charm. This relatively feminine dimension to the model was also supported, enabling Pat to have her identities as an artist, a good science student, and a girl affirmed.

Both the bone song and the magnet impacted the learning community in that they became part of the classroom discourse as models for other ways to engage in science activity. Unlike Ginny's bone song, which was used as a learning heuristic across the 6th grade that very year, Pat's magnet indirectly impacted the class, as it was consistently referred to as an example of how students' future work could be different. We noted that in the following school year, many students elected to build three-dimensional models for their animal project after Pat's teacher highlighted her magnet, which still occupied its place on the blackboard (Field notes, March 22, 2006).

As these examples illustrate, signature science artifacts fostered the creation of hybrid spaces in science because the girls who created them introduced them into science class as artifacts of science, allowing them to draw upon a combination of their funds of knowledge (i.e., artistic talent, popular culture) along with traditional science classroom resources (i.e., science textbook, ideas discussed in class). At the same time, these artifacts also supported the girls' exploration of content knowledge while elevating or maintaining the value of their social worlds.

The girls in our study made artifacts that merged their social worlds with the world of school science for motives other than completing assignments in nontraditional ways. Often, these artifacts bridged science and their worlds so that the perceived importance of science could help them to gain access to resources or to elevate the perceived value of their social status. In the following example, we can see how Crystal and Star built bug collectors to do just this.

One warm spring afternoon, we observed Crystal building what she termed a "bug collector" during free time in Mr. R.'s science class. Crystal's bug collector was made of objects she found in her classroom: two clear plastic cups taped together with one end cut open and covered with cheesecloth. Crystal described how she had made it and where she had gotten the idea:

Crystal: And I said, yeah. But how we gonna catch the bugs? We can't catch them in our hands. We can't put them inside a bottle. I said yeah you're totally right. . . . We saw two cups and I had an idea, and Mr. R had cheesecloth, the spoons, the two little big cups, and tape. So I decided to tape both of the cups and make a hole in the bottom of one of the cups and then put cheesecloth over it so that way the bugs can breathe and that way they don't get out.

Researcher: Wow. And did you just make this up or have you seen this before?

Crystal: I just made it up actually, but I seen it in the TV shows and everything but they used different tools and everything.

Researcher: So you just used what you found?
Crystal: Yeah, I used what I found, and I used two spoons that way I can put it in.
Researcher: And what are you trying to catch today?
Crystal: A few ladybugs, whatever we can find that's good.
Researcher: And Star, do you want to tell me about your container?
Star: Yeah, mine is the same way as hers. We made it the same way.

Crystal told us that she made the bug collector as a reason to be able "to go to the school garden." The garden was a fenced-in, overgrown plot of land on the school's property that was usually off-limits to students. From prior conversations, we knew that the girls knew this. Yet, we observed Crystal requesting permission to use her bug collector in the garden, and her strategy worked: "That day we had not even planned to go to the garden, but the girls were so excited about using the tools they had specially made that I could not say no. I was also very curious about the tools and how they would use them" (Field notes, April 27, 2004). During their visit to the garden, the girls were being loud, and a teacher stuck her head out the window and asked if they had permission to be there. Crystal said only, "Yeah, we're doing science!" by way of justification.

Star, on the other hand, made a bug collector just like Crystal's so that she could hang out with Crystal and her friends catching bugs:

> After school that day I was surprised to see Star come to meet me along with the rest of the girls and so I assumed that she and Crystal had collaborated on the tools and that Crystal had invited Star to the garden with us. However, when I began to talk to the girls I realized my assumption was incorrect. Crystal had told me that Star copied her without her permission and that she just wanted to be able to go along with them. Later when I talked to Star I realized also that [Star] did not see herself as copying them but wanting to participate in the same way to show that she could be with them. (Field notes, April 27, 2004)

This example shows how Star used the status of a science artifact to try to gain entry into a new social circle. She was successful in that she gained access to the garden with the other girls. Even though her success in gaining access to Crystal's group of friends was somewhat short-lived, the experience made her feel like a scientist, as was evidenced by an interview later on where she explained that she wanted to "build a terrarium like a scientist" from the bugs she collected.

There are several other examples we could present in support of creating science artifacts. There were narratives where girls made paper puppets, created figures, and came up with dances and skits, all of which were tangibles used in support of a science activity, none of which were required by the assigned activity. Some of the artifacts impacted both the individual girl and the entire classroom learning community. However, some artifacts stayed within small-group activities, directly impacting a small discourse community and only indirectly shaping the larger classroom community.

In short, the practice of making signature science artifacts is important because in these narratives students' funds of knowledge shape the actual product and their reasons for doing so (i.e., to have fun, to gain access to friends, to maintain social status and identity while still doing well in science). However, in each of these narratives, the product was both an artifact of and a contributor to a new kind of hybrid space that challenged and reshaped both academic science and the knowledges and discourses of youth's everyday lives. Each artifact described required a familiarity with key ideas in science relevant to the focus of the science class or activity. This knowledge was critical to the conceptualization of the artifact as well as to the girl's ability to leverage that artifact within the school context.

Playing With Identities

The girls in our study often purposefully and playfully took up identities that were new and distinct from their usual science class identities in order to build epistemic or positional authority while maintaining important social relationships. We use the phrase *playing with identities* because in nearly all of the instances in which we noted girls taking up novel identities, there was a degree of lightheartedness that was attached to the trying on of the new identity. The lightheartedness was associated with the girls wanting to have fun, to establish stronger peer relationships, or to reduce the risk of taking up science, rather than a lack of seriousness in learning. We also noted that while these identities did not neatly fit into who the girls were in science class, they were not necessarily disconnected from the girls' whole selves. They often reflected dimensions of the girls' lives that were active outside the boundaries of science class.

Take, for example, the case of Tricia and Pat's "save the animals" poster presentation. During the actual presentation, the girls began with a rhetorical question, "What you do affects the environment. Pollution, oil spills, forest fires affect us all. But as long as it's not affecting you, it's ok, right?" Once the class yelled out "Right!" the girls playfully but forcefully responded with "No! Wrong! Animals each year, each month, each week, each day are being killed. Everything we do affects the environment!" Each girl then went on to explain why this was the case. For example, Pat said,

> What you do is important to our environment. You're so happy with your life aren't you, so happy. Buying snakeskin jackets, hamburgers, all these things are everything you want. But have you ever asked yourself where these things come from? From nature! You do this, burn down the trees to fit your needs, have you ever said that you care about the environment? This bird never did anything to you, so why do you pollute its air, food, sky, everything. Stop polluting the air and things will get better. Stop buying snakeskin jackets, hamburgers, and you will live much better. Save the environment.

The girls ended by reciting their final points together, in rhythm, in a way that could have been taken for a rap: “You cut down trees to meet your needs.” At the end, the class erupted into applause and Mr. M. praised the girls, saying, “It’s so great. We’re a little in shock.” When he asked the audience what they liked about the presentation, one of the boys known for being disruptive and inattentive was called to answer. He responded, “Everything, I don’t know what to say!”

While Pat and Tricia were good science students, doing well in science was not something they showcased. Presenting one’s work in science class, however, often forces students to make that aspect of their classroom identity public, putting them at risk of being labeled a nerd or even acting White. While in a midyear interview they both admitted to being good in science, they were apprehensive about their peers viewing them as “tak[ing] things too seriously” and having “too much smartness and questions.” In this example, Pat and Tricia used their rhetorical skills to play out an identity that positioned them as smart and scientific, yet still cool and playful.

We believe that playing with identities supports girls in engaging more deeply in science content or in classroom activities in ways that either reduced risk taking or bolstered their position in class. Take, for example, the case of Melanie. From our participant observations, we viewed Melanie as a very quiet student in science class. When we were present, she would almost always say “pass” when called upon to answer a question, and we could find no evidence in our field notes or videos of her volunteering to talk in whole-class discussions or lectures in the first two quarters of the school year. She explicitly stated to us that she was not a “good” science student and was not “smart” in science.

For her animal project, Melanie chose to study gorillas. During the presentation of her written report, Melanie took on the role of gorilla expert, the female scientist Jane Goodall. Apart from meeting the requirements by reporting on information such as the habitat, food, and lifecycle of the animal, she also enlisted the help of two friends, Pat and Chantell, to act as gorillas while she “taught” them sign language in the persona of Jane Goodall. The teacher and her peers gave Melanie riotous applause, and she earned 100% on her report (Field notes, January 8, 2005).

A few weeks later, Melanie was working with her partner, Catherine, on a “save the animals” poster on giraffes. On their poster they had drawn a mother giraffe with her baby and a tree with the recycling symbol. During their presentation, Melanie also held up a separate piece of paper with the words “WE ARE RESPONSIBLE.” After Catherine explained how deforestation affects giraffes, Melanie impersonated the mother giraffe and her baby:

> We drew a tree because not only the giraffes need it but we need it too ’cause, um, of the air. . . . Plus the giraffes will starve. We drew the giraffes saying “I’m hungry! Help us! Help my family! We need trees to eat the leaves!” and the little one, the baby is saying, “Help me! And my mummy! I’m starving!”

These stories of Melanie impersonating Jane Goodall and a mother giraffe may seem mundane, but Melanie, as we noted in our field notes, seemed to be a "painfully quiet student" who lacked confidence in her ability to do well in science class. Using the giraffe as a safe haven, Melanie was able to share what she knew and to begin to position herself, more publicly, as someone who could talk about science. As reported elsewhere (Tan & Calabrese Barton, 2006), these impersonations were crucial turning points in Melanie's transformation from a marginal to an exemplary science student-leader.

Playing with different identities also allowed girls to actively position themselves with different forms of authority in the classroom—forms of authority they did not always have in science class or that were not always valued in science class. In the last example, Melanie positioned herself with traditional epistemic knowledge, drawing upon her research into giraffes. In the case of Tricia and Pat, we see them bridging their epistemic authority into positional authority among their peers—trying to maintain that they could be smart yet cool.

Many times, girls were playful with identities in ways that allowed them to transform their narrative authority, or authority that they have through their lived experiences, into meaningful epistemic authority in the classroom. For example, when students were asked to make a presentation on the dangers of smoking, Amelia, a student who struggled to be taken seriously in science class, drew upon her street identity (in both her oral and body language and in her knowledge claims) to call attention to some of the dangers of smoking learned on the street. Amelia wrote the script for her group and played the central "villain" in the skit where she gets kicked out of both school and home for "smokin'" and now lives and hangs out in the park distributing cigarettes to other youngsters. At the end of the skit, her character dies from smoking-related diseases, and another member of her gang takes over her role to lure more youngsters to smoking.

In another example, Crystal took it upon herself to monitor and water a potato experiment that had been neglected by her science class after the official lab was done. On her own time, Crystal continued to monitor the plants, make sure they always had enough water, and record daily observations. When seeking approval for using science time for the potato activity, Crystal took on the role of knowledgeable community elder, drawing upon her knowledge of growing potatoes in Puerto Rico, as she explained to Ms. O., the science teacher when her regular teacher, Mr. R., went on medical disability leave:

Crystal: I did it in Puerto Rico once. Me and my grandma planted potatoes.

Ms. O.: She had land?

Crystal: Yeah. Well not really, it's not her land. It used to be her father's land until he died, and now Pearson took over his house.

Ms. O.: And you planted potatoes?

Crystal: Yeah, he used to have a little square where we planted vegetables and everything, mostly carrots and potatoes. And once I planted it and it grew, and he ripped it off.

Ms. O.: Why did he rip it off?
Crystal: Well, he did it. He ripped it up from the root because he wanted to see something. He was teaching me about plants. . . . Well it looks like that. Potatoes probably have a little something inside it that looks like a potato hasn't grown yet. It has little, tiny seeds inside, and it has seeds to grow bigger and bigger.

Crystal ultimately sent an e-mail to Mr. R. about her findings, writing, "So I think that when potatoes are brown everything they are not really fully grown, and when you plant them again and feed them water they start to grow more. So I think the one in our classroom is growing more and more out of one little potato plant." Although Crystal mistakenly called the potato buds "seeds," she understood from her farming experiences that the potato was the source of vegetative propagation.

When girls played with identities, they were granted opportunities to explore new science-related identities without eclipsing other aspects of their identities. When girls played with identities, they drew upon in-school and out-of-school resources and experiences to construct novel identities that protected them in taking risks in the science classroom and in bolstering peer support.

Negotiating Roles Through Strategic Participation

A third merging practice that girls engaged in was that of negotiating roles through the purposeful deployment of participation strategies. This practice, like playing with identity, was especially important because it appeared to lower the girls' risks when participating in science and trying out new science ideas. Here, we report only on the girls' negotiated roles when they appeared to be directly related to how the girls attempted to have some influence over how a content-driven activity got done in class, knowing that this also directly impacts the broader social dimensions of the class. Furthermore, we believe this practice supported and elevated the girls' profiles in the learning community because, as we will show in the examples that follow, it was a practice often taken up by the girls to change, over time, what it meant to participate in science class.

For example, during the fall semester, Amelia was frequently reprimanded by her teacher for her disruptive behaviors, such as chewing gum loudly, talking during class, or making derogatory statements about others. Her teacher referred to her as a "bully" and a "problematic student." Her peers did not regard her as a helpful member of the classroom community, as evidenced by students complaining when they were grouped with her (Field notes, September 23 and 29, 2004). While Amelia consistently received 70s for her science grades, as researchers, we learned directly from Amelia through our interviews in the fall semester that she loved science. Her declared love of science was substantiated by the fact that during the middle of the fall semester, she enrolled in the Saturday science field-trip program offered for free by the school and never missed a single trip during the school year. We began to see a disjunction between the tough street identity she enacted frequently in class and her desire to succeed in science.

Yet, we noted that partway into the fall term Amelia seemed to be participating more constructively in class. When we began to look more closely at the classroom video, we noticed that she did not change her ways of being in the classroom very much. Instead, she seemed to co-opt the standard classroom rules so that they fit her interaction styles, giving her a way of participating in class as a competent science student rather than as a problem. For example, she still moved about the classroom when students were expected to sit quietly, but as we saw in the worm poop example, she used "science reasons" for her movement, giving legitimacy to being up and about. She also began to employ gestures more frequently to signal to the teacher that she wanted to answer the next question, by nodding her head or pointing to the reading packet and then at herself (Field notes, March 10 and 13, 2005; April 8 and 15, 2005; May 12 and 31, 2005). We also observed that her teacher took up and began to expect these different norms for participation, often looking to Amelia for her signals. We observed that over time Amelia became known as someone who was smart in science. Indeed, Amelia moved from a Level 1 (failing grade) student in the first term to a Level 3 ("very good" grade) student in the third term.

One of the reasons why we favor viewing Amelia's actions as negotiating new roles through strategic participation is that her classroom community was marked by specific rules and roles for participation. Her teacher was a strict disciplinarian. For example, he constantly reminded students of the rules in his classroom: "When I hold my hand up, what are you supposed to do?" or "I only call on students who have their hands raised." We mention this not to belittle her teacher—in fact, his clear set of rules most likely contributed to his well-managed class, enabling him to engage his students in a variety of hands-on activities not observed in other classrooms at this school. Yet, we also know that across school spaces, students often resist these school rules, especially when these rules place them in positions without voice (Fine, 1991). So, when Amelia and other girls devised different roles and rules for participating, and these were acknowledged or sanctioned by their teacher, it was notable.

We are not suggesting that all girls should devise their own strategies for participation that counter the norms of the classroom or that even all out-of-school identities are productive in school. We do believe it is worth noting how girls seek to circumvent the norms for participation when those norms seem to silence them or marginalize those very aspects of themselves that support their growth in science.

In another example, Jackie did not want to handle the worms on the day her class did the worm observation lab. She pushed her chair away from the table and proclaimed, "They're nasty!" The teacher had been reminding the class that they all needed to participate in observing the worms, creating a dilemma for Jackie that could be seen in her body language. Jackie instead made it her job to record the observations her group mates called out, adding her own details as she observed the worm interactions in her peers' hands (e.g., "cold," "wet," "slimy," "smells like earth," "3 and a half inches"). At the end of the lesson, when the teacher was conducting a whole-class discussion of the students' findings, Jackie pushed her worksheet to the middle of the group and contributed substantively to the class conversation (Field notes, October 21, 2004).

While we had hoped that Jackie would touch the worms, we noted that her facility in fashioning her role in both the small group and the whole class opened up at least a smaller venue in which to begin to feel comfortable exploring worms. She positioned herself during the whole-class discussion as the group's authority on worms by being the scribe for the group. Jackie's negotiation of roles in this example is also highly problematic. She struggled to dutifully perform the required tasks of the classroom while shying away from activities that seem less feminine. Science is often thought about as a masculine activity, and one form this can take is that of getting messy with nature. We also find it problematic that Jackie took up the recording activity and shied away from playing around with the worms, for these are actions documented by research to limit girls' experiences in science. But, instead of completely turning away from the worms, she peered over her group mates' hands to confirm the observations she heard and to add new ones of her own to the worksheet. Jackie's example thus illustrates how merging practices can serve as tools for greater participation while still constraining movement toward full engagement in the science learning community.

In the previous examples, we noted that girls negotiated roles that deviated from explicit classroom rules and norms. Yet, we also noted that girls negotiated roles that deviated from implicit roles and rules but nonetheless highly sanctioned modes of participation. In this next example, Ginny created a set of rules for her small group to follow in order to complete an assignment that examined the relationship between weather and farming patterns. Group members were to complete a worksheet with seven questions focused on farmers and weather. Ginny initiated the group by assigning a sequence for everyone to answer each question, also vocally deciding that that every member had to offer an answer before the group reached a consensus for each question: "Ok, let's get started. Everybody has to answer the question, first Melanie, then Pat, then me, then Katherine." Ginny insisted on keeping to her arrangement and often had to tell Katherine, a more assertive group member, to wait her turn, especially when Katherine interrupted a much quieter student, Melanie.

Katherine: My opinion is that . . .
Ginny: Wait. You have to wait. I'm explaining to Melanie.

Ginny's requirement that all students answer all of the questions probably reflected the teacher's ideal for group participation. However, it differed from what typically happens in the groups in this class and in most classes we observed, where only a few group members participated, and the task got done more quickly. Group members were all given time to speak by Ginny, and the weaker members of the group were also encouraged to participate, even though it slowed the group down, as evidenced by the fact that Ginny's group finished last.

Finally, we see science as an integral part of negotiating roles because this practice involves how one participates in the science learning community, not simply the classroom community, and second, changing the rules often invoked the content, authority, or context of doing science. These examples illustrate how success in negotiating roles was grounded in knowledge across domains. The girls demonstrated knowledge of the spoken and unspoken rules for participation and how such rules might be disrupted without getting the girls into trouble. The girls also drew upon their funds of knowledge to fashion ways of participating that highlighted their interests and strengths, maintaining or raising their positions and profiles in class. Girls enacted roles that enabled them to be viewed as legitimate participants in science activity rather than in just classroom activity. Amelia had the teacher's and her peers' attention with her disruptions, but her rule making allowed her disruptions to serve as entry into science participation. Sometimes the girls had to prove their roles by drawing upon the authority of science (i.e., "I need to do this for science") or powerful identities valued in the science classroom (i.e., nice girl, science girl, smart girl).

Discussion: Creating Hybrid Spaces

The narratives reported here reveal how girls actively, flexibly, and creatively built hybrid spaces for engaging in science. These hybrid spaces brought together sanctioned and unsanctioned resources and identities in novel ways that supported who the girls were and wanted to be, extended their participation in school science, and transformed their learning communities. In what follows, we look across the three practices of creating signature scientific artifacts, playing with identity, and negotiating roles to make sense of how girls' enactments of these practices fostered new hybrid spaces. In what follows, we discuss two main points. First, these merging practices supported generative third spaces, transforming learning and participation over time. Second, merging practices support third spaces that have outcomes for both the authoring girls and the larger learning community.

The Generative Nature of Third Spaces

The practices of creating signature science artifacts, playing with identities, and negotiating new roles for participation allowed the sociocultural worlds of the girls to become integral components of school science, resulting in what we refer to as new hybrid spaces. These merging practices are, in a sense, acts of cultural bricolage as the girls attempted to manage differences between their worlds and the worlds of school science. What makes these girls' practices noteworthy is that their efforts at bricolage merged knowledges and identities that likely (indeed historically) would have been marginalized, symbolically if not practically, in the science classroom, allowing them to produce new, hybrid knowledges and identities that were sanctioned in the classroom.

Hybridity theory reminds us that hybrid spaces are not static—they are contextually configured, and they shift when new actors, resources, and histories come into play. Consequently, it is helpful to think about the construction of hybrid spaces dynamically. When we apply this idea to the data presented in this manuscript, a clearer picture begins to emerge regarding the relationship between what these girls were doing when they were making science artifacts or playing with identities and how that impacted their 6th-grade science classes.

The girls actions put into play progressions in the classroom that legitimized unsanctioned resources and capital in science and made the access and activation of these resources highly valued by others in that sociocognitive space. At the beginning of the year, students enter a classroom space made up of science norms, social norms, and classroom norms initiated by the teacher and the curricula she or he chooses to enact, among other things. These spaces are not fixed and can look quite different from classroom to classroom. For example, they can be restrictive in a traditional teacher-dominated classroom or in a classroom where the teacher might lack knowledge of and a desire to learn about students' out-of-school lives.

Yet, through their practices, the girls helped to foster hybrid spaces that either created or sustained a need for the resources and identities they brought to bear but that normally might not be considered part of science class. For example, when playing with identities, the girls engaged in science class in ways that foregrounded their knowledge, experiences, and needs, not all of which mirrored the sanctioned purposes of the science activity. In fact, we would argue that this space does more than just validate the girls' out-of-school identities and resources—this space relies upon these resources as integral components in their science learning. As the merging practices were taken up by others, including their teachers, they shifted what kinds of resources mattered in science class and how activation of these resources could make grappling with scientific ideas tenable and even enjoyable. These newly legitimized resources, in turn, expanded the science learning community in terms of legitimate knowledge, resources, and identities. Thus, we refer to these as *progressions* because we also see the process as ongoing and generative. Helping to create spaces that foster certain kinds of identities broadens the classroom culture over time, making spaces for new kinds of discourses, knowledges, and identities to potentially emerge.

For example, Pat's rabbit magnet opened up the opportunity for other students to generate models instead of diagrams for their animal projects, offering the entire 6th grade a new way to complete the animal assignment. More subtly, the teacher's support of Melanie's playful identities as her way of engaging in whole-class discourse created new safe spaces for Melanie to take risks and talk science in the classroom. If we take the case of the bone song, we see how Ginny's use of music and dance offered her a tool for playing with scientific ideas. The teacher's ideas about how he might teach the skeletal system shifted such that not only did he hold up Ginny's song as a good piece of student work, but in the subsequent year he taught Ginny's song and integrated music into his science teaching more generally.

Understanding the shifting communities of practice in science class vis-à-vis merging practices is important because it illuminates how these new and tentative hybrid spaces allowed for new forms of legitimate participation to emerge. What we are saying is that the girls' engagement was built not just on a bridging but also on a merging of these worlds. The very act of, for example, creating the bone song, changed the discourse regarding learning bones in the classroom and what it meant to learn about bones, while it simultaneously shifted how Ginny thought about the way her artistic self mattered in science class.

Drawing from Moje's work on critical literacy practices, we refer to these hybrid spaces as third spaces, or spaces where the discourse of science class and of the girls' social worlds were blended, making the boundaries between these worlds porous and movement between these worlds fluid. It is in this new discourse space that new forms of participation in science class were legitimized, thereby extending the repertoire of resources available to all students.

Third Space and Learning Science: Transforming Individuals and Communities

Engaging in merging science practices fostered learning environments that supported girls in learning science and also supported their participation. We have already alluded to how the mechanisms by which such support took place transformed the learning experiences of both the individual student and the larger community of practice. Below, we reference specific examples to further the argument that merging practices support third spaces that have both individual and community outcomes and that both must be examined together if we want to fully understand how such practices support student learning.

For example, at the beginning of the school year, Amelia was described by her teacher as a "bully" and a "troublemaker" who frequently came to class without her science notebook. In one of our last interviews with her in 6th grade, Amelia rated herself a 6 out of 7 for being good in science, saying that "science is my favorite subject . . . our test scores, I'll always get a 90 or above." She also rated her enjoyment of science a 7 as compared to her other school subjects, citing the interesting content she got to learn, the science field trips she took, as well as the rapport she built with the science teacher:

> I never knew about the ozone layer being destroyed, I never even HEARD of ozone. . . . Mr. M's fun. . . . Like the Saturday trips, where we have to bring a parent? I use to go to everyone, and my parents . . . and uh, the camp, that we did . . . that was fun, and Mr. M was there, and

> my parents, they like him too ’cause he’s a great teacher. . . . [I’m] raising my hand all the time in class.

While we believe it would be impossible to document any causal reasons for such change, we did note that on those occasions when we observed Amelia being supported in blending her social identity with being scientific, as was the case with the worm poop and antismoking skit episodes described earlier, she engaged deeply and centrally in the classroom discussion. For Amelia, these experiences compounded, and she ended the school year as what she referred to in her interview as a “poster child” for science. Her teacher also began to solicit her field-trip stories in class to further discussions (Field notes, September 23 and 29; October 21, 2004), and she offered a testimonial at parents’ night on the value of the field trips (Field notes, March 2, 2005).

When Ginny created her signature science artifact, the bone song, she scored a 95% on the skeletal system exam. Her teacher also publicly acknowledged her creativity with the bone song, raising Ginny’s profile with her teacher and peers as a smart, creative, science student. A telling indicator of the enduring effects of this event was the fact that Ginny and her friends could still remember the lyrics and dance moves of the bone songs 4 months after the skeletal system test when they spontaneously performed it for us during an interview. Ginny’s teacher was so impressed with her bone song he used it as a pedagogical tool to launch the skeletal unit for the next batch of 6th graders during the following academic year.

When Melanie role-played Jane Goodall for the presentation of her animal project, she negotiated her participation by “becoming” an expert scientist. She scored 100% for her presentation and won the affirmation and approval of her peers and teacher. Her peers were able to see a different side of her through this event—one that was confident, funny, engaging, and most important, authoritative. At the end of the school year, when Melanie was asked in an interview to discuss her favorite science class or activity, she responded as follows:

Melanie: My favorite project, was, I agree with Pat, the animal project, um . . .
Researcher: How did Pat help you?
Melanie: She was the gorilla. And I was the scientist.
Pat: She was Jane Goodall.
Melanie: Yeah, I was the scientist teaching the gorillas the sign language.
Researcher: Oh, how did you get the idea to be Jane Goodall?
Melanie: I read the book. It says that the scientist teach the gorillas sign language . . . like, this means peace and some other sign language I forgot. And, I knew that I was gonna get a good grade and I got a 100, and Chantell was the sound effect.
Researcher: What do you mean she was the sound effect?
Melanie: She made the gorilla sounds. And also, this scientist, this is the scientist who taught the gorillas [shows picture from project].

This response to her project was far different than the 23% she received during the first marking period. She later went on to score 100% in the marking period when they studied animals. When Melanie's teacher began to notice how Melanie gained a foothold in classroom discourse through taking on other identities, he purposefully began to incorporate role-playing in his teaching practices to potentially offer similar spaces for other students (Field notes, January 21, March 10 and 11, 2005).

Opportunities to craft third spaces that supported the blending or merging of the girls' outside-of-science resources and identities with those available and legitimized in school science, therefore, fostered individual and community change by supporting new and more opportunities to participate meaningfully in the science classroom, students' epistemological and social status, and in some cases their school achievement (i.e., test scores and grades). These merging science practices are significant not just to the individual girl's science learning, but the effects of these events also impacted the classroom discursive norms in terms of the resources and identities allowed in class and how and why science literacy is defined, demonstrated, and enacted.

Implications and Conclusions: Urban Girls and Learning

We view our understanding of merging science practices as an approach to understanding the ways in which certain practices can help girls, and perhaps all youth, merge the world of school science with their life worlds and that these merging science practices can be made more transparent for teachers. These practices offer unique insight into how context frames engagement in science and how it frames the girls' reasons for participating in science, issues missing from most of the literature in science education. While the practices documented in our article are not always explicitly scientific, they carry scientific significance when the girls used them in ways that advanced their science trajectories. In other words, merging science practices served as gate openers in the sense that they fostered increased participation in the science learning community, making access to more traditional practices possible.

What makes these merging practices unique to or important for urban African American and Latina girls—the very girls in our study? We believe that all youth engage in acts of hybridity. As cited earlier, however, we agree with Roth (2006) that some youth are marginalized because their acts of hybridity are punished by symbolic violence. With respect to this point, we see three important implications regarding urban girls.

First, the examples presented in this article point toward the ways in which merging science practices help to challenge and reshape both academic and everyday knowledge and discourse, rendering more transparent the ways in which these knowledges and discourses overlap and potentially inform the other. Symbolic violence reflects the ways in which daily practices produce and foster social and cultural domination (Bourdieu, 1977). We believe that merging practices disrupt the daily routine of science class, enabling the girls, their teachers, and their peers to move toward discourses and activities that favor identities and resources outside the sanctioned realm, opening up new forms and spaces for meaningful participation. For example, Amelia's antismoking skit made possible the inclusion of a wide range of gang-related experiences around the realities of smoking, which become educative rather than taboo in her classroom.

Second, many of the examples of the practices we cite carry intonations that reflect how girls are positioned through the hidden curriculum of schooling. We know that traditionally girls are positioned with less power in the science classroom. Girls are called on less often to answer content questions and are not given as much attention as the boys by the teacher. These merging practices and the ensuing third spaces help to reduce girls' risks in seeking to overcome these barriers and by centrally positioning other ways of participating in the classroom community that matter. By rendering, for example, one's experiences in Puerto Rico, a critical dimension of how one makes a scientific argument, girls like Crystal can confer epistemic authority upon their lived experiences.

Third, while we resist categorizing practices in ways that promote either stereotypical or essentialized experiences for urban girls from African American and Latina backgrounds, we have noted recurrent threads in some of the qualities that frame their practices. Many, but not all, of our examples reflect tendencies not only to merge a girl's out-of-school resources and identities with that of school science but also to capture, to an extent, a way of being that is both feminine and streetwise. Caring for others, care for work produced, self-reliance, movement, verve, art, and music dominated many of our examples and are described elsewhere as connected to the funds of knowledge and ways of being that urban African American and Latina youth often value and enact in out-of-school settings (Moje et al., 2004; Rolon-Dow, 2004; Seiler & Elmesky, 2007; Thomas, 2007). We opted to foreground identity in our analysis instead in an effort to reflect the dynamic and fluid nature of cultural practices that develop and shift over time. This connects us back to our first point. It is precisely these ways of being or enacting knowledge in the classroom that tend to be marginalized and to induce symbolic violence.

The role of the teacher in coconstructing these third spaces that supported the blending of girls' social worlds and school science cannot be ignored. Teachers draw upon structural (i.e., use of informal time such as after school or field trips) and pedagogical strategies (i.e., using role playing, supporting song writing, etc.) to support girls' merging practices and to build such hybrid spaces with their students where science is no longer "another world" (Costa, 1995). The hybrid spaces are always a joint construction and significantly different from traditional classroom spaces in specific ways. It is in these hybrid spaces where teachers' structural and pedagogical choices allow them to share authority with their students—allowing students to take on, however momentarily, the identity of an expert rather than a novice—and where students can feel what they have to contribute matters and is of value. By diversifying the communities that can be represented in a science classroom, teachers effectively broadened the legitimate number of roles (also subject entry points) girls can play in science class through drawing on more tools and resources than can be found in a traditional science class. These widened entry points, resources, and roles sanction students' nontraditional funds of knowledge and highlight the connection science has to their everyday living (Boullion & Gomez, 2001; González, Moll, & Amanti, 2005; Hammond, 2001; Seiler, 2001). By drawing and validating from such nontraditional funds of knowledge, teachers coconstruct antioppressive hybrid spaces with their students: Teachers learn where their students come from, build on their out-of-school proficiencies, and make connections between their existent knowledge with what they need to learn in science class (Buxton, Carlone, & Carlone, 2005).

The attention to covert or unsanctioned discourses, identities, or knowledges made legitimate through the coconstruction of hybrid spaces, therefore, helps to uncover that which transpires in the science classroom that is not typically part of what counts yet that still impacts a girl's ability to engage the normative structures of the science classroom. Recent policy attention regarding gender, ethnicity, and science for all, especially in urban centers, has focused primarily on achievement without attention to students' ontological development and its role in how or why youth might pursue a science trajectory. Yet, we know these concerns are critical. Girls—especially girls from low-income and minority backgrounds—are not moving into the sciences and are negatively impacted at every juncture of the pipeline. Becoming a participating member of any science learning community involves figuring out how one's subjectivities can align with science, that one has knowledge and experiences that will support further development of deeper understandings, and that this information has utility.

Merging science practices have the potential to reshape the landscape of school science, rendering it less foreign and reducing the risk for students not well equipped with traditional school-sanctioned resources. Such hybrid spaces need to be brokered for collectively by the school science community of practice, including both students and teachers. When taken up by teachers, merging science practices can create hybrid participation spaces that allow students to draw from a wider base of funds of knowledge to more fully participate in school science experiences. Such hybrid spaces have the capacity to redefine student participation because in these blended spaces they have the chance to shed the identity of a powerless novice and take on, to a larger degree, an identity of expert or leader. The teacher's role is also transformed in hybrid spaces where she or he ceases to be the sole possessor of or authority on legitimate scientific knowledge. Like Moje (Moje et al., 2001), we believe that the creation of these hybrid spaces is much more likely to come about in the context of reform-based curricula, which privilege to a greater extent than traditional science teaching the coconstruction of educative experiences in the classroom. However, we also believe that such student-empowering experiences brought about by merging science practices and the hybrid spaces they create are an important key to fostering student interest and performance in school science.

Notes

This material is based upon work supported by the National Science Foundation under Grant No. PGE 0429109 and a Spencer Foundation small grant. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the Spencer Foundation.

[1]The names of all people and places are pseudonyms.

References

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36,* 269–287.

American Association of University Women Educational Foundation. (1999). *Gaining a foothold: Women's transitions through work and college*. Washington, DC: Author.

Atwater, M., Wiggins, J., & Gardner, C. (1995). A study of urban middle school students with high and low attitudes toward science. *Journal of Research in Science Teaching, 32,* 665–677.

Barton, D., & Hamilton, M. (2000). Literacy practices. In D. Barton, M. Hamilton, & R. Ivanic (Eds.), *Situated literacies: Reading and writing in context* (pp. 7–15). New York: Routledge.

Boullion, L., & Gomez, L. (2001). Connecting school and community partnerships as contextual scaffolds. *Journal of Research in Science Teaching, 38*(8), 899–917.

Bourdieu, P. (1977). *Reproduction in education, society and culture*. Beverly Hills, CA: Sage.

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching, 38*(3), 282–295.

Brickhouse, N., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441–458.

Brickhouse, N., & Potter, J. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching, 38*(8), 965–980.

Buxton, C., Carlone, H., & Carlone, D. (2005). Boundary spanners as bridges of student and school discourses in an urban science and mathematics high school. *School Science and Mathematics, 105,* 302–313.

Calabrese Barton, A. (2007). *Urban girls' science practices*. Unpublished technical report to the National Science Foundation, Arlington, VA.

Carlone, H. B. (2004). The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching, 41*(4), 392–414.

Cole, M. (1995). The supra-individual envelope of development: Activity and practice, situation and context. In J. J. Goodnow, P. J. Miller, & F. Kessel (Eds.), *Cultural practices as contexts for development* (Vol. 67, pp. 5–16). San Francisco: Jossey-Bass.

Conlin, M. (2003, May 26). The new second sex. *Business Week* [online].

Costa, V. (1995). When science is "another world": Relationship between worlds of family, friends, school and science. *Science Education, 79*(3), 313–333.

Donmoyer, R. (1990). Generalizability and the single-case study. In E. Eisner & A. Peshkin (Eds.), *Qualitative inquiry in education: The continuing debate* (pp. 175–200). New York: Teachers College Press.

Fine, M. (1991). *Framing dropouts: Notes on the politics of an urban high school*. New York: State University of New York Press.

Gee, J. P. (1996). *Social linguistics and literacies: Ideology in discourses* (2nd ed.). London: Falmer.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. Chicago: Aldine.

González, N., Moll, L. C., & Amanti, C. (Eds.). (2005). *Funds of knowledge: Theorizing practices in households and classrooms*. Mahwah, NJ: Lawrence Erlbaum.

Gutiérrez, K. D., Baquedano-López, P., & Tejeda, C. (1999). Rethinking diversity: Hybridity and hybrid language practices in the third space. *Mind, Culture and Activity, 6*(4), 286–303.

Hammond, L. (2001). Notes from California: An anthropological approach to urban science education for language minority families. *Journal of Research in Science Teaching, 38*(9), 983–999.

Howes, E. (2002). *Connecting girls and science: Constructivism, feminism and science education reform*. New York: Teachers College Press.

Kelly, G. J., & Chen, C. (1999). The sound of music: Constructing science as sociocultural practices through oral and written discourse. *Journal of Research in Science Teaching, 36,* 883–915.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lee, C. D. (1993). *Signifying as a scaffold for literary interpretation: The pedagogical implications of an African American discourse genre* (NCTE Research Report 0085-3739, No. 26). Urbana, IL: National Council of Teachers of English.

Lee, J. (2002). More than ability: Gender and personal relationships influence science and technology involvement. *Sociology of Education, 75*(4), 349–373.

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English-language backgrounds. *Educational Researcher, 27*(4), 12–21.

Lopez, N. (2003). *Hopeful girls, troubled boys: Race and gender disparity in urban education*. New York: Routledge.

Malcolm, S. (1997). Girls succeeding in mathematics, science and technology: Who works and what works. In *American Association of University Women Conference Proceedings*. Philadelphia: American Association of University Women.

Miller, B. (1995). Precepts and practices: Researching identity formation among Indian Hindu adolescents in the United States. In J. J. Goodnow, P. J. Miller, & F. Kessel (Eds.), *Cultural practices as contexts for development* (Vol. 67, pp. 71–85). San Francisco: Jossey-Bass.

Moje, E. B. (2000). "To be part of the story": The literacy practices of gangsta adolescents. *Teachers College Record, 102*(3), 651–690.

Moje, E. B., Ciechanowski, K. M., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly, 39,* 38–72.

Moje, E. B., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is 'quality'?": Language, literacy, and discourse in project-based science. *Journal of Research in Science Teaching, 38*(4), 469–498.

National Academies [National Academy of Sciences, National Academy of Engineering, and Institute of Medicine]. (2007). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering*. Washington, DC: National Academies Press.

National Center for Education Statistics. (2004). *Highlights from the Trends in International Math and Science Study (TIMSS) 2003*. Washington, DC: U.S. Department of Education.

New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review, 66,* 60–92.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. *Review of Research in Education, 16,* 153–222.

Oakes, J. (2000, May). *Course-taking and achievement: Inequalities that endure and change*. Keynote paper presented at the National Institute for Science Education Forum, Detroit, MI.

Orenstein, P. (1994). *Schoolgirls: Young women, self-esteem, and the confidence gap*. New York: Doubleday.

Parker, L., & Rennie, L. (2002). Teachers' implementation of gender-inclusive instructional strategies in single-sex and mixed-sex science classrooms. *International Journal of Science Education, 24*(9), 881–897.

Reid, N. (2003). Gender and physics. *International Journal of Science Education, 25,* 509-536.

Reveles, J., Cordova, R., & Kelly, G. (2004). Science literacy and academic identity formation. *Journal of Research in Science Teaching, 41*(10), 1111–1144.

Rolon-Dow, R. (2004). Seduced by images: Identity and schooling in the lives of Puerto Rican girls. *Anthropology and Education Quarterly, 35*(1), 8–29.

Roth, W.-M. (2006). Bricolage, métissage, hybridity, heterogeneity, diaspora: Concepts for thinking science education in the 21st century. *Cultural Studies of Science Education, 1*(1), 1–42

Sadker, M., & Sadker, D. (1995). *Failing at fairness: How America's schools cheat girls*. New York: Macmillan.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38*(9), 1000–1014.

Seiler, G., & Elmesky, R. (2007). The role of communal practices in the generation of capital and emotional energy among urban African American students in science classrooms. *Teachers College Record, 109,* 391–419.

Seiler, G., Tobin, K., & Sokolic, J. (2003). Reply: Reconstituting resistance in urban science education. *Journal of Research in Science Teaching, 40*(1), 101–103.

Strauss, A. (1987). *Qualitative research for social scientists*. Cambridge, UK: Cambridge University Press.

Street, B. (1984). *Literacy in theory and practice*. Cambridge, UK: Cambridge University Press.

Street, B. (2001). Literacy "events" and literacy "practices": Theory and practice in the "new literacy studies." In K. Jones & M. Martin-Jones (Eds.), *Multilingual literacies: Comparative perspectives on research and practice*. Amsterdam: John Benjamins.

Sungur, S., & Tekkaya, C. (2003). Students' achievement in human circulatory system unit: The effect of reasoning ability and gender. *Journal of Science Education and Technology, 12*, 59–64.

Tan, E., & Calabrese Barton, A. (2006, April). *Melanie's transformation*. Paper presented at the American Education Research Association annual meeting. San Francisco, CA.

Tate, W. (2001). Science education as a civil right: Urban schools and opportunity-to-learn considerations. *Journal of Research in Science Teaching, 38*(9), 1015–1028.

Thomas, A. (2007). Gendered, racial socialization among African American mothers and their daughters. *Family Journal, 15*(2), 137–142.

Tobin, K., Elmesky, R., & Seiler, G. (2005). *Improving urban science education: New roles for teachers, students and researchers*. Lanham, MD: Rowman and Littlefield.

Varelas, M., Becker, J., Luster, B., & Wenzel, S. (2002). When genres meet: Inquiry into a sixth-grade urban science class. *Journal of Research in Science Teaching, 39*(7), 579–605.

Yin, R. (1994). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.

Manuscript received February 27, 2007
Revision received August 10, 2007
Accepted August 22, 2007