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Engaging Girls' Sociohistorical Identities in Science

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What does it mean for ethnic minority girls, who have historically been marginalized by schools, to "see themselves" in science? Schools fail to create spaces for students to engage their identity resources in the learning of science or to negotiate and enact new science-related identities. This study investigates relationships among identity, engagement, and science discourse and provides a conceptual argument for how and why underserved ethnic minority girls engage in collective identity work, with science learning as a valued byproduct. The primary context for the study was Lunchtime Science, a 4-week lunchtime intervention for girls failing their science courses. There were 4 distinct ways the girls engaged in learning during Lunchtime Science: gleaning content for outside worlds, supporting the group, negotiating stories across worlds, and critiquing science. Each pattern had a signature profile with variations in the sociohistorical narratives used as resources, the positioning of one another as competent learners, and the type of science story critiqued and constructed. These findings indicate that when the girls were given opportunities to engage their personal narratives, and when science was open to critique, ethnic minority girls leveraged common historical narratives to build science narratives. Moreover, the girls' identity work problematizes the commonplace instructional notion of "bridging" students' everyday stories with science stories, which often privileges the science story and the composing of "science" identities. It also challenges researchers to investigate how the construction of narratives is broader than 1 community of practice, broader than 1 individual, and broader than 1 generation.

Eloisa is a vibrant young woman developing ideas about herself as a daughter, a Mexican American, and a budding environmentalist. The first time I observed

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Eloisa in biology, she passionately described the deforestation of rainforests in South America. Later, she recounted this as one of the few times she was able to share her "opinion" about science and about her culture with classmates. Eloisa more typically was a silent bystander in biology. Her classroom interactions with others were limited and constraining. During a group investigation to test environmental impacts on plants, for example, she watched as group members talked about pouring Windex™ on plants. Her suggestions for a more authentic study design were dismissed by classmates. To complicate matters further, she did not interact with her biology teacher other than to ask where assignments should be turned in. Eloisa was now failing biology, and her experiences were difficult for her to reconcile with her experiences in middle school science classes, in which she had forged an identity of herself as a scientist, particularly when doing "hands-on" experiments.

Understanding how Eloisa is positioned as an outsider or nonparticipant through classroom interactions can account for her disengagement, but it does not explain when or how she *does* engage in learning. To understand why Eloisa engaged in the deforestation project, one would need to understand how this event was connected to conversations with her mother about land in Mexico and about Eloisa's deep sense of pride in being Mexican, exhibited through other acts of engagement such as learning traditional dances. It is through these varied worlds that Eloisa made sense of her past, present, and future visions of herself in and outside of science class.

Schools cannot afford to continue to perpetuate patterns of inequities that lead to disengagement and school dropout. The human costs of failing children are high: Children who drop out of school tend to have lower self-esteem, tend to have lower social and political participation, and are less likely to have stable and satisfying jobs (Fine, 1991). Experts clearly need to understand how students who are marginalized because of their low academic performance, race, gender, language, and income *can and do* engage in learning. From a sociocultural perspective, understanding engagement means understanding participation in communities of practice (Wenger, 1998) and in particular the discourses that both signal and leverage that participation (Engle & Conant, 2002). Yet studies investigating science talk in classroom settings have understandably focused on students who actually speak. The paradox is that marginalized students, particularly learners who are female and non-White, often do not have opportunities to see and express their identities through school science and miss a critical prerequisite for learning science—that is, *talking* science (Barton, Tan, & Rivet, 2008; Brickhouse & Potter, 2001; Carlone, Haun-Frank, & Webb, 2011; Johnson, Brown, Carlone, & Cuevas, 2011).

Through language, students participate in the construction of ideas about themselves and about subject matter. These forms of talk, however, are often constrained by historical schooling structures and institutional scripts that enforce a

narrow set of norms for ways of talking and being in a science classroom (Moje, Collazo, Carrillo, & Marx, 2001). This means that in typical science classrooms there are a limited set of identities—such as "being a good student" or "wanting to become a scientist"—for girls to align with and build on (Brickhouse & Potter, 2001; Carlone et al., 2011; Varelas, Kane, & Wylie, 2011). In contrast, progressive learning environments that break with traditional scripts by changing the participation roles students can take on, access to the domain, and opportunities for self-expression have the potential to support girls in new forms of participation in science (see Barton & Tan, 2010). But even in such environments, girls on the margins of schools have fewer opportunities to engage in identity-related talk—talk that connects to their lived experiences, their social selves, and their cultural roots (Huber, Whelan, & Clandinin, 2003; Thompson & Windschitl, 2005).

This study investigates how 17 girls like Eloisa—girls from nondominant cultures who are marginalized by schools—engaged in the construction and critique of science ideas as they participated in the 4-week Lunchtime Science (LS) intervention. I examine how the girls' *identity work* across multiple worlds of school, home, and culture (Barton et al., 2013; Costa, 1995) shaped their individual and collective engagement in LS, and conversely how their engagement in LS shaped identity processes within, and in some cases beyond, the group. This study contributes theoretically to the understanding of identity processes linked to gender, ethnicity, positioning, and alignment with the institution of schooling. The literature review is organized around these constructs and is divided into two sections: discussion of engagement in identity work across contexts and classroom constraints for developing scientific narratives.

ENGAGEMENT IN IDENTITY WORK ACROSS CONTEXTS

I begin with the assumption that learning is a form of identity work. I define engagement in identity work as a student's investment of time and effort (Fredricks, Blumenfeld, & Paris, 2004; Newmann, Wehlage, & Lamborn, 1992) in *negotiating ideas about oneself as a person in history and as a product of interactions with others* and in the process *authoring oneself to others* (Holland, Skinner, Lachicotte, & Cain, 1998). In a cultural practice, such as playing dominos or basketball, engagement is marked by the degree to which players attend to the game, draw on relevant prior knowledge to focus their attention, use smooth transitions between game and nongame talk, and develop relationships with others in the game (Nasir, 2002). Similarly, in cultural spaces such as classrooms, productive disciplinary engagement (PDE) is marked by interactions among students in which they pose puzzling questions about the subject matter, complete one another's sentences with overlapping talk about science explanations, and transition between on- and off-task conversations (Engle & Conant, 2002). In these

heightened forms of observable participation, individuals work with others to negotiate and author themselves while taking into account how they are positioned by others in local interactions, in a social history, over developmental time, and by cultural expectations (Holland et al., 1998). In Eloisa's example of engaging in a deforestation project and publicly sharing her ideas, for instance, she drew on historical, cultural narrative resources and for a moment in time was recognized for a different form of participation in her science classroom.

Identities are stories constructed by self and others within a given way of believing, acting, and interacting (Gee, 2001). To understand how engagement in the construction of stories is socially situated, I conceptualize identity as a *process,* not a product; as *decentralized from individuals,* not as an essentialist core; as represented by *multiple identities,* not a single identity; as *rooted in culture and language* rather than individual thinking; as *dynamic,* not constant across time; and as *interrelated with others' identities and actions in the world* rather than individualistic (Gee, 2001; Holland et al., 1998; Markus & Kitayama, 1991). Within this frame, personal actions are understood in the context of how one's identities are negotiated through language, through one's social context, and through one's current and historical interactions with others.

One of the challenges to studying identity work from this perspective is that girls from nondominant cultures constantly bridge multiple worlds, and identities are often constructed across these worlds, not just within practices (Barton et al., 2013). Important to this study then is how identities, as discursive and collective processes, are distributed across activities and settings. Here I draw on Holland and colleagues' (1998) idea of figured worlds. Figured worlds are more than just a setting, they are "socially produced, culturally constituted activities" (pp. 40–41) that girls are recruited or enter into, where girls can develop, refine, or recreate identities within and beyond established ways of participating. As the girls in this study engage in identity work in and across socially constructed worlds of race, gender, school science, and an informal science intervention, they refine narratives about themselves and set visions for future participation.

The literature has good examples of how narratives are shaped discursively by participation in multiple figured worlds and how these influence learning for the individual. Sfard and Prusak (2005) suggested that narrative development happens through the listening and telling of stories about oneself and others across multiple worlds. In this way, identities are collections of narratives from interactions with others that are (a) reifying, meaning they are real to the individual and reflected in patterns of talk; (b) endorsable, meaning they reflect the narrator's view of the world; and (c) significant, meaning that if the story were changed in any way it would change how the narrator acts. Narratives about "designated identities"—stories about "what is expected to be the case in the future"—tended "to act as self-fulfilling prophecies" (p. 19) among high-achieving students as they worked toward their future visions in school. However, students struggling to

receive passing grades are less likely to have identities prealigned with the goals of school (Brickhouse & Potter, 2001), and those shaping students' narratives are less likely to be teachers and classmates (Thompson & Windschitl, 2005), thus making classrooms a difficult place to construct or negotiate designated identities and support learning.

Ultimately, few studies have examined how girls from nondominant cultures engage discursively in science classrooms and what narrative resources they individually *and collectively* draw on to participate in these settings. This article makes an important break from others examining identities in science learning spaces; rather than just examining how narratives are individually constructed within a community of practice (Wenger, 1998), I focus on how collective identities, shaped by common sociohistorical identities, develop and fortuitously shape science learning. The present study explores two assumptions about engagement in collective identity work across figured worlds. The first is that there are themes across individuals' developing narratives that are reflective of social positioning and that may function as a common resource. P. H. Collins (2000), for example, described how collective narratives can arise from multiple, intersecting forms of oppression, including "racism, misogyny, and poverty" (p. 26), standpoints uniquely experienced by Black women. Collins was clear, however, that these crosscutting tension-related themes also intersect with other developing narratives and that not all individuals will have the same response. Important to this study then are the possible ways these developing narratives collectively affect learning for ethnic minority girls in schools. Fittingly, the second assumption is that no two girls will be engaged in exactly the same identity work; they are building narratives across different contexts with different critical narrators, and these narratives reflect not just individuals but histories of those who have come before (Rogoff, 1998). This study explores how engagement in learning occurs given these assumptions about individual and collective identity work.

DEVELOPING NARRATIVES IN SCIENCE THROUGH DISCOURSE: CONSTRAINTS IN CLASSROOMS AND POSSIBILITIES IN ALTERNATIVE CONTEXTS

In this section I explore why schools and classrooms are difficult places for underserved students to work on narratives and build disciplinary narratives from a discourse perspective. I also outline the evidentiary basis for principles used to design the informal science intervention project for this study.

For marginalized students there are limited opportunities to develop narratives about oneself and one's science classroom community because there are often few opportunities to engage in substantive talk. It is known, for example, that participation in science classrooms is constrained by a limited number of

participation roles, limited access to the domain, and limited opportunities for self-expression (Nasir & Hand, 2008). There is some evidence that these constraints might be particularly magnified for ethnic minority girls, who are underrepresented in science fields or who are underachieving in school (National Research Council, 2007; Thom, 2001). It is known that students who are not aligned with the goals of schooling (Brickhouse, Lowery, & Schultz, 2000), or middle-class European-centered forms of cultural expression (Fordham, 1996), or particular forms of science talk (B. A. Brown, Reveles, & Kelly, 2005) are often positioned at best as nonparticipants and at worst as outsiders (Kurth, Anderson, & Palincsar, 2002) or disruptive outcasts (Wortham, 2003). Students can easily be labeled with productive or maladaptive discursive identities simply by how they interject ideas and how the teacher and classmates receive their contributions (B. A. Brown et al., 2005).

In typical classrooms there are not only limited roles students can take on but limited access to the domain. This is particularly true in low-tracked classrooms that tend to favor students playing a far less participatory role in disciplinary discourse (Gilbert & Yerrick, 2001). Ideas up for discussion in these classrooms are typically not oriented toward authentic problems or conceptually rich scientific explanations; instead teachers will often do the majority of explaining or have students take stabs at guessing correct answers (Horizon Research International, 2003). From a disciplinary perspective, engaging in the practice of school science requires using scientific language to forward a group's thinking about scientific ideas, not just the parroting of facts and concepts. Productive conversations, for example, are those in which students use increasingly sophisticated arguments over time, make new connections among scientific ideas (Engle & Conant, 2002), critique others' claims for the purpose of constructing explanations (Ford, 2012), and coordinate theories with evidence (Herrenkohl & Guerra, 1998).

Reorienting classrooms to support scientifically rich dialogue is necessary but not sufficient for supporting the development of students' identities. Experts have yet to understand how participation in disciplinary practices intersects with students' current identity work, both in and outside of school science. However, two research studies have documented ways in which it is possible for students to engage in disciplinary discourse and build relevant narratives beyond ascribing to a particular career. Huber and colleagues (2003) described how young children built identities in a literacy class by asking questions of one another, asking questions of teachers, using playful language, and metaphorically laying personal stories alongside literature. Sharing stories provided students with tools for reasoning with personal *and* collective stories (Lee, 2001; Rosebery, Ogonowski, DiSchino, & Warren, 2010). The other study took place in an after-school club in which activity structures better intersected with work the children were already doing with communities, family, and peers. Barton and Tan (2010) described how, through specialized forms of talk and new participation structures, children in

GET City assumed roles as community activists and challenged traditional norms for conveying science to others.

For the present study I developed an LS program that aimed to make shifts in learning opportunities by using students' history-in-person (Holland & Lave, 2001) narratives to inform what science content was incorporated and how students might engage in the material. This study builds on the notion that science learning spaces should be places for learners to "reconcile the identities they are invited to construct with the types of identities they value" (Cobb & Hodge, 2002, p. 277). In this study, specific attention was given to individual and collective learning about selves and science through actualized identity and science talk (Ford, 2012). The primary research questions were as follows:

1. How do ethnically diverse, underserved high school girls negotiate the use of science discourse when provided with opportunities to engage in identity-related activities? How do they critique and construct scientific ideas?
2. How do the girls leverage individual and collective narrative resources in episodes of heightened collaborative engagement (PDE)? How does positioning by instructors and peers influence their engagement?

STUDY DESIGN

Participants

I applied a case study approach (Stake, 1995) to understand the activity of 17 underserved ethnic minority high school girls and their work in LS. The participants in this study were part of a larger group of 40 girls I worked with in other research studies from 2002 to 2006 (Thompson & Windschitl, 2005). I asked four science teachers to identify students earning low grades and/or exhibiting poor attendance. Similar to patterns in underserved urban schools, the majority of the girls identified as struggling in science were low-income ethnic minority youth. Of the 17 girls, 13 described themselves as African American, two as Asian, one as Native American, and one as Mexican. Eleven of the girls received free or reduced-cost lunch, and six of the 17 eventually dropped out of school (see Table 1). The girls attended Central High School (a pseudonym), a large institution that serves a diverse population of students in a low-income neighborhood. The school typically enrolls more than 1,700 students representing multiple racial backgrounds: about 47% Caucasian, 33% African American, 14% Asian, 5% Latino, and 2% Native American. There is some evidence that in racially diverse schools, low-income students and students of color suffer disproportionately from the negative effects of tracking (Oakes, 2005). This might partially account for

TABLE 1
Participants and Participation in School Science and LS

				Participation in School Science		*Participation in LS*		
Insider/ Outsider Status	*Participant*	*Ethnicity*	*GPA*	*Role/Discursive Identity*	*Historical Narratives Leveraged*	*Attendance (%), Units 1/2*	*Role/Discursive Identities*	*Historical Narratives Leveraged*
I. LS, school, and science insiders	Tara[a,b]	Asian American	3.0	Active participant, answering questions	Doing school Connecting with teacher Becoming a wildlife biologist Maintaining friendships	100/60	Asking questions and leading inquiries	Becoming a wildlife biologist Designing experiments Maintaining friendships Doing school
	Kiana[a]	African American	2.5	Passive participant	Doing school Connecting with teacher	89/80	Coteaching, sharing facts from science class, and sharing personal stories	Being an animal caretaker Helping and teaching others Maintaining friendships Connecting with teacher
II. LS insiders/ becoming insiders in school and school science	Kalisha[a]	Native American	2.5	Passive participant	Doing experiments	78/80	Keeping the group on task, evaluating studies, and telling personal stories	Helping and teaching others Doing experiments Being an athlete
	Sandra[a]	African American	2.5	Passive participant	Doing experiments Doing school Connecting with teacher	67/60	Participated more over time, telling personal stories, asking questions, and challenging ideas	Helping and teaching others Designing experiments Debating and sharing opinions Maintaining friendships

(*Continued*)

TABLE 1
(*Continued*)

				Participation in School Science		*Participation in LS*		
Insider/ Outsider Status	*Participant*	*Ethnicity*	*GPA*	*Role/Discursive Identity*	*Historical Narratives Leveraged*	*Attendance (%), Units 1/2*	*Role/Discursive Identities*	*Historical Narratives Leveraged*
	Eloisa[a]	Mexican	2.4	Passive participant, participated more after LS	Doing experiments	89/100	Asking questions and sharing opinions	Helping and teaching others Designing experiments Sharing opinions Connecting with teacher
	Kira	African American	2.3	Passive participant, participated more after LS	Doing school Connecting with teacher Doing experiments	100/80	Participated more over time, asking questions, suggesting study designs, and reporting facts	Helping and teaching others Becoming a doctor Doing experiments Connecting with teacher
	Tia	African	2.1	Passive participant	Doing experiments Connecting with teacher	100/90	Sharing personal stories and ideas from science class and asking clarifying questions	Helping and teaching others Designing experiments Becoming a doctor Connecting with teacher
	Alisa[a]	African American	1.9	Passive participant	Doing experiments Doing school	100/90	Sharing facts from science studies	Helping and teaching others Designing experiments

III. LS insiders/ becoming insiders in school	Lavonn[b]	African American	3.0	Passive participant, participated more after LS	Doing school	100/90	Participated more over time, asking and answering questions from science studies, teaching others, joking with others, and telling others to participate	Helping and teaching others Maintaining friendships Connecting with teachers Doing school
	Jazelle[c]	African American	2.4	Passive participant, participated more after LS	Connecting with teacher	100/80	Participated more over time, asking questions, joking with others, and connecting with the teacher	Connecting with teachers Maintaining friendships
	Amy[a,b]	Asian American	2.2	Passive, infrequent participant	Doing school	56/0	Quiet, infrequent participant	Making healthy choices Maintaining friendships
	Catrina	African American	2.1	Passive, infrequent participant	Doing school	56/40[d]	Quiet, infrequent participant	Helping and teaching others Doing school Maintaining friendships
	Yevette[c]	African American	2.2	"Loud" participation		78/80	Participated more over time, telling personal stories, and asking questions	Helping and teaching others Maintaining friendships
	Shyla[a,c]	African American	2.0	Rarely attended class	At odds with school because NOT "a nature person"	67/30[d]	Quiet, infrequent participant	Making healthy choices At odds with LS because NOT a "nature person"

(*Continued*)

TABLE 1
(*Continued*)

				Participation in School Science		*Participation in LS*		
Insider/ Outsider Status	*Participant*	*Ethnicity*	*GPA*	*Role/Discursive Identity*	*Historical Narratives Leveraged*	*Attendance (%), Units 1/2*	*Role/Discursive Identities*	*Historical Narratives Leveraged*
	Donna[a,c]	African American	1.4	"Loud" participation	At odds with school because NOT "a smart person"	67/80	Sharing personal stories and asking clarifying questions	Being someone who "speaks up"
V. Outsiders to LS and school	Jewel[a,c]	African American	1.7	Rarely attended class	At odds with school because NOT "a nature person"	44/10	Infrequent participation	At odds with LS because NOT able to maintain friendships and does NOT want to become a mother
	Patricia[c]	African American	1.8	"Loud" participation		22/0	Passive, infrequent participation	At odds with LS because NOT a "nature person" and NOT a person who does school work

Note. LS = Lunchtime Science; GPA = grade point average.
[a]Second-year LS student who participated in 2003 and 2004. [b]Student passed the science portion of the 10th-grade state assessment. [c]Student dropped out or would not graduate on time. [d]Student was suspended during part of LS.

why each year about 1 out of every 4 students drops out of school, the majority of whom are from nondominant cultures.

Although all of the participants struggled in freshman biology, they had different academic backgrounds that led them to have varying degrees of connection with school. For the purposes of understanding the girls' participation in school, I organized the girls into five groups based on their insider or outsider status (see Table 1). These are not categories the girls necessarily identified with, but they are intended to show how the girls were positioned in school. In terms of these categories, girls were considered *school insiders* if they participated in doing typical activities in their classrooms and their grade point averages were improving. They were considered *science insiders* if they actively worked on developing narratives in science-related activities, including school science. They were considered *LS insiders* if they regularly attended and verbally participated in LS activities. Group I—LS, school, and science insiders—initially struggled in science classes, but at the time of LS they had improved their academic performance and were on track to graduate. These girls also had a background of engaging in extensive science-related conversations. For example, Kiana's father was a zookeeper, and she reported that they watched television programs about animals on a weekly basis and then had conversations about caring for animals. Group II—LS insiders, becoming insiders in both school and school science—had histories of struggling in science (and in some cases all courses), but all reported being engaged in science classes, particularly when they had opportunities to design their own experiments. Group III—LS insiders, becoming insiders in school—raised their grades by the end of the first semester of their freshman year and did not express a particular connection to science or science classes other than wanting to pass the class. Girls in Groups I, II, and III had ways in which they participated in "doing school" and empathetically described the importance of connecting, or attempting to connect, with their teachers as a way to support their learning.

Group IV—LS insiders, becoming outsiders in both school and school science—struggled in science and other subjects and never experienced the same gains in school as Groups I, II, or III, yet these girls successfully participated in LS. Girls in Group V—outsiders to both LS and school—were marginalized by school as well as LS. LS did not provide a context for the girls to leverage historical narratives they had developed outside of school, and these girls quickly assessed that LS was at odds with how they viewed themselves (see Table 1). All of the girls in Groups IV and V dropped out of school or were not on track to graduate on time. Moreover, many of the girls in these groups had a "loud" presence in the classroom as opposed to the girls in Groups I, II, and III, who were virtually silent. Fordham (1996) described how African American youth must sacrifice the expression of cultural identities in order to fit with high-achieving school identities of largely middle-class European-centered schools, hence "acting White" (Ogbu & Fordham, 1986, p. 176) and not "being loud." Girls in

Groups IV and V, however, had few opportunities to identify with school, had few successes in school, and most likely differentially experienced the tension between identifying with the predominant White culture in schools and cultural ways of being outside of school.

Instructional Context for LS

To understand what engagement might look like for girls who are struggling in science, this study purposefully constructed a context that supported the girls in learning about themselves and about science. The program ran daily for 4 weeks in the spring of 2004. Ms. B and I, both Caucasian women from middle-class backgrounds, cotaught LS in her classroom during a 50-min lunch period. I made lunches for the girls, and at the beginning of the lunch hour the girls collected food and pushed the tables together to form a large rectangle. The instructional activities varied each day but often included large-group discussions; small-group discussions; independent reading of newspaper articles; and "just-in-time" content injections from myself, Ms. B, or invited guests (a doctor, a nurse practitioner, and asthma researchers).

Based on interviews with the girls, I selected three topics that might relate to the girls' lives and that connected to substantive science ideas. The girls voted and selected two topics: prenatal health care and inner city pollution problems related to asthma. In the first unit, the girls conducted scientific inquiries with fish eggs to make comparisons with human embryological development. The second unit included an inquiry with secondary data on pollution, but as the unit unfolded it was apparent that the girls were more interested in understanding asthma. We designed, administered, and analyzed results from a school-wide survey about causes of and triggers for asthma.

Instructional strategies in the units were based on principles from (a) engagement in identity work across contexts and (b) engagement in science-specific discourse. These principles were intentionally separated to attend to the multiple ways girls inscribe and perform identities in and outside of science.

Engagement in Identity Work. The first set of principles described here promoted exploring, building, and negotiating ideas about oneself and group membership.

Laying stories alongside curriculum. The first principle is that individuals should have opportunities to metaphorically lay their stories about "who I am," "who I am becoming," and "importance of relationships" alongside the science curriculum (Huber et al., 2003; Thompson & Windschitl, 2005). Students were encouraged to share their personal stories and experiences, were given case studies

of hypothetical friends who were seeking their advice, and then designed investigations stemming from the girls' interests. Instructors also modeled this. Ms. B, for example, shared her experience growing up with asthma. The girls frequently returned to this story for initial evidence of how asthma affects the lungs and common environmental triggers.

Expressing oneself and having others respond. Simply telling stories does not afford opportunities for girls to engage in negotiating ideas about themselves. Thus, the second principle is that learners need others to respond to their stories. This second principle, relating to social discourse, gives the storyteller opportunities to hear "critical others" build on her ideas and offer alternative perspectives or content-related ideas that can enhance the disciplinary ideas related to the storyteller's narrative (Sfard & Prusak, 2005). The instructors encouraged students to respond to one another's stories based on their own lived experiences and highlighted key scientific differences among stories. When a girl took ownership of a particular science idea, oftentimes after reading a newspaper article, instructors encouraged other students to listen carefully to her ideas and directed them to talk to the girl who had become the "expert" in a particular science idea.

Building a sense of belonging. The third principle supports the first two principles. Telling, listening, and building on stories depends on interactions with "significant narrators" (Sfard & Prusak, 2005, p. 18), or people who helped shape the girls' ideas about their lives outside of school or inside LS. Within LS, the girls were encouraged to reflect explicitly on how interactions in the group were developing to help establish an affinity identity, or sense of membership with the group (Gee, 2001), as a way to position the girls as critical others for one another.

Engagement in Science Identity Work. The second set of principles that informed LS was derived from an instructional approach that aims to foster engagement in scientific discourse, described as PDE by Engle and Conant (2002). In theory, these principles of participation support girls in performing and developing science identities.

Problematizing curriculum and asking questions. The first principle is that the content should be problematized and should encourage students to ask questions, challenge ideas, pose problems and solutions, and hypothesize rather than be recipients of static information (Warren & Rosebery, 1996). Starting with a problem that is substantive to students and how they view themselves will support them in shaping their own learning experiences, developing expertise in the classroom, and participating more productively in scientific discourse. For this study, the topics of prenatal health care/embryological development and asthma/the environment (issues identified by students) were framed as problems that related

to how the students viewed themselves in the present and in the future: What advice should we give a friend who is drinking during pregnancy? Why is asthma on the rise across the nation, including in our neighborhood? Instructors also used questions that surfaced during the unit to adjust content and the direction of the scientific inquiry.

Giving students the authority to solve problems. The second principle is that students are given authority to answer these questions, which gives them ownership in the learning process (Ball & Bass, 2001; Lampert, 1990). This was achieved by having students design their own questions and then answer them through scientific inquiries. For example, in the first unit some of the girls were interested in understanding "a healthy pregnancy," and they explored the role of folic acid and other vitamins during development. During the second unit, some girls wanted to explore the effects of smoking on asthma, as they lived with smokers and had relatives with asthma.

Holding students accountable to others and to disciplinary norms. The third idea is that students are held accountable, as producers of knowledge and as stakeholders, to scientific content and practices through the creation of a community of learners (Michaels, O'Connor, & Resnick, 2008) who consult and respond to one another's ideas. Students were also held accountable to scientific norms for critical evaluation of scientific studies. The goal was to enhance scientific literacy and provide the girls with tools they could use to be critical consumers of science information (Roth & Barton, 2004).

The following prompts provided a linguistic tool for holding students accountable to disciplinary norms. When examining a scientific study, such as those in newspaper articles, the girls were taught to ask the following: *What is the scientist's purpose? What was good and what was bad about the methods? Does the scientist represent or misrepresent the data? Are the claims legitimate?* These questions were strategically designed both to help the girls critique findings from scientific studies and to expose disciplinary norms relating to epistemological beliefs (such as understanding that scientific findings are tentative) and practices of science (B. A. Brown, 2006).

Instructors also used more general talk moves to support girls in airing out ideas with others (Michaels & O'Connor, 2012). Such strategies included using wait time and asking girls to "say more" or revoice other girls' ideas. To support more cross-talk we juxtaposed girls' ideas, asking, "Does everyone agree with Kiana's idea about how chemicals travel to the fetus? Who disagrees? Why?"

Providing resources. The fourth PDE principle is providing relevant resources. Resources in LS included having time to explore a problem in depth (A. Collins, 1998; Henningsen & Stein, 1997), having access to laboratory materials

and scientific information (from newspaper articles, science texts, and specialists in the fields of midwifery and asthma research), and being exposed to conceptual frameworks and tools that could facilitate reasoning out a problem and learning the requisite linguistic tools (B. A. Brown, 2006; Lampert, 1990). The instructors often layered on content with the ideas girls were working on and at the same time modeled how to glean information from readings.

Drawing on student knowledge and language to coconstruct a scientific story. This fifth principle is not considered a stand-alone principle in Engle and Conant's (2002) PDE model. It is included to support the intersection of everyday social language of science and school science. Researchers advocate starting with students' everyday social language to build scientific explanations of phenomena (Donovan & Bransford, 2005; Mortimer & Scott, 2003). It is important to note that I distinguish between building *the* scientific story versus a science story that is coconstructed with students' stories. In this way, both the students' everyday language and the social language of science can be thought of as student tools (Wertsch, 1991). The purpose is not just to move students from everyday social language to a scientific (or school science) social language but rather to enhance their ability to apply such language in new situations. For example, at the outset of LS, the girls would either evaluate the quantity and quality of information or evaluate the importance of a study's claims for themselves and others. After learning a protocol for critically evaluating scientific studies, the girls folded this everyday language into scientific critiques of studies and applied this knowledge when developing week-long scientific inquiries. To this end, the girls were positioned as both critics and producers of scientific stories (Barton & Tan, 2010).

DATA COLLECTION

Primary data sources included 29 hr of videotaped lunchtime sessions, 88 hr of audiotaped individual interviews, 10 hr of audiotaped small-group interviews, and 14 hr of classroom observations in the girls' regular science classrooms. Tapes of the interviews and LS units were transcribed in full.

Documenting participation in their regular classrooms and in LS was straightforward, but to understand the girls' reflective talk about their participation, I conducted several rounds of interviews. First-year participants were interviewed a total of five times and second-year participants eight times (approximately 1 hr per interview). All participants were interviewed individually before and after LS, after LS in small groups, and 2 years later individually as a follow-up. Prior to LS the girls were asked to describe episodes of engagement in extracurricular activities, in a favorite class, and in science class. Following each LS unit of instruction, girls were asked to describe how they experienced the unit personally,

interpersonally, and intellectually. After the second unit, girls were also asked to compare the two inquiry experiences and the role they played in each. I also conducted group interviews that targeted students' scientific meaning making. Two years after LS, I asked the girls to share a historical perspective on their high school science courses and ways they participated over time and any long-term influences of LS.

DATA ANALYSIS

Research studies typically use analytical tools from Wenger's (1998) communities of practice framework to describe engagement as a form of belonging in *a* community of practice. Although this study draws somewhat from this framework, the analytical tools were not nuanced enough to characterize learning as socially situated in *and* across time and settings. For this analysis I was most interested in understanding how girls marginalized by schools engage in identity work in and outside of scientific discourse. I wanted to understand how nonscience identity work (or engagement in multiple figured worlds) informs science identity work and vice versa. I chose to blend analytical tools from two identity theories and one engagement theory to examine individual and collective dimensions of sociocultural activities. In terms of identity I used both narrative and discursive tools. The narrative approach (Sfard & Prusak, 2005) foregrounds how identities are constructed over time and in the contexts of social histories, which includes stories of family, race, and gender. The discursive approach (B. A. Brown et al., 2005; Gee, 2001) provides a lens for examining identity processes such as how students are positioned as learners and nonlearners in classroom interactions and how students' identities are constructed or revealed through classroom conversations. To characterize engagement in science-specific identity work I used tools from the PDE framework (Engle, 2012; Engle & Conant, 2002). The challenge with just using tools from these perspectives alongside one another was that each alone could not account for both individual and collective forms of engagement. Thus, I blended these perspectives and derived four types of analysis.

Engagement in Identity Work Across Contexts—Individual Focus

To characterize engagement in identity work from an individual perspective, I identified each girl's *narrative resources,* or the kind of identity talk that supported the construction of identities across multiple contexts in the girl's life. I was interested in how participation in one activity was related to participation in another (Rogoff, 1998). I examined interview data about self-reported prior engagement in science class, a favorite class, and an extracurricular activity. Episodes of

engagement were marked by talk about time, effort, commitment/investment, and concentration (Fredricks et al., 2004; Newmann et al., 1992). Instances of identity talk about "who I am," "who I am becoming," and "the importance of relationships" (Thompson & Windschitl, 2005) were marked by "I" and "we" statements; repeated statements of beliefs and values; described interactions with others from the girls' multiple worlds (Costa, 1995); and the use of past, present, and future language (Sfard & Prusak, 2005). Using analytic induction strategies, I determined characteristic themes for each girl. Examples included "helping others," "teaching others," "respecting others," "connecting with others," "learning about one's ethnic culture," "valuing learning by doing experiments," "taking care of the environment," and, for a few, "entering a science-related field." I used these themes to examine the girls' talk in and about their participation in their current science class and LS, paying attention to consistencies and inconsistencies (Merriam, 1998). From this analysis, I created *engagement/identity maps* for each student (see the Appendix for Alisa's example). These maps were organized by context (across the top) and themes from the students' identity work (down the left side) as well as untapped identity resources that were not a part of the girls' stories of participation (often these were images of possible selves in a career). I asked the girls to comment on the maps in member checks in 2006. Themes with the richest descriptions across data sources were used for pattern clarification and cross-case analysis (Huberman & Miles, 1994).

Table 1 includes a summary from these individual maps with comparisons of how the girls participated in school science classes versus LS. The table compares and contrasts the girls' roles and discursive identities across each setting (based on observational data) and historical narratives the girls reported drawing on (based on observational and interview data). As is indicated by Table 1, almost all of the girls were passive participants in their school science classrooms and active participants in LS. Some of their roles were new, and others were opportunities to build on ways of interacting the girls had developed in other contexts.

There were *few* noticeable changes in insider/outsider status. This might be a bit much to expect of a 4-week out-of-school intervention not aimed at addressing inherent institutionalized issues around school failure. However, four girls (Eloisa, Kira, Lavonn, Jazelle) built stronger relationships with their science teacher and began participating more and receiving passing grades in their regular science class. In one extreme case, this meant that Eloisa had to challenge her assumption that her teacher was "racist."

Engagement in Identity Work Across Contexts—Collective Focus

To examine patterns of collective identity development, I examined the kinds of identities that were available and created in LS as a community of practice (Wenger, 1998), the girls' *positioning* in small- and whole-group conversations

(B. A. Brown et al., 2005; Holland et al., 1998; Yamakawa, Forman, & Ansell, 2009), and then compared these discursive acts to the girls' stories about their roles as participants in LS. In their reflective and in-the-moment discourse I coded four different types of positioning: (a) positioning self with science ideas—first-person singular (I, me, my), (b) positioning self with others in group—first-person plural (we, us, our, the group), (c) positioning others—second-person (you, your) or third-person (other students' names) pronouns, and (d) positioning outside source (text, third-person reference to other people the girls knew outside of the group). I also examined LS discourse and interview data for references to the LS group to understand any formation of an affinity identity (Gee, 2001), sense of belonging (Wenger, 1998), or sense of the collective purpose of the girls' work in LS (Nasir, 2002). These analyses informed the development of the four patterns of engagement reported in the findings.

Engagement in Science Identity Work—Individual Focus

To characterize each girl's *type of science talk and participation,* I identified specific patterns of discourse for each girl when she engaged in episodes of productive disciplinary discourse. I analyzed both the content and interactional style of each statement each girl made. Examples of such patterns included giving a scientific explanation, evaluating science methods, sharing facts, coteaching by advocating for others, sharing personal stories, asking clarifying questions, and responding to and revoicing others' science ideas. Note that some of these patterns are dependent on interactions with others; thus, collective and individual coding was not mutually exclusive. Some of these discourse moves were productive in getting girls to interact with the LS curriculum; others kept the conversation moving forward. This analysis was added to the engagement/identity maps for each girl (see the Appendix).

LS supported the girls in critiquing and constructing evidence-based explanations (Braaten & Windschitl, 2011; Sandoval, 2003). At the outset of LS, the girls would evaluate the quantity and quality of information or evaluate the importance of a study's claims for themselves and others (see Table 2, 1s and 2s). After practicing a protocol for critically evaluating scientific studies, many girls who participated actively in LS added critiques of studies based on the sample and experimental methods used and the evidentiary basis for the claims (see Table 2, Bs and Ds). This was consistent across both post-LS assessments. A few girls also began to critically evaluate the study purpose and question data representations (see Table 2, As and Cs).

More than just critiquing scientific stories, the girls used these linguistic tools to construct scientific explanations about healthy prenatal development and why asthma was on the rise in their neighborhood. The themes in the Findings section

TABLE 2
Girls' Use of Naturalistic and Scientific Critiques of Scientific Studies

Girl	*Pre-LS*	*Post-LSI*	*Post-LSII*
Tara	1, 2	1, 2, B, D	1, 2, B, C
Kiana	1, 2	1, 2, B, C, D	A, B, D
Kalisha	1, 2	1, 2, B, C, D	2, A, B, C, D
Sandra	2	2, B, D	A, B, D
Eloisa	1, 2	1, 2, B	1, 2, A, B, D
Kira	1, 2	1, 2, A, B, D	1, 2, B, C
Tia	1, 2	1, 2, A, B, D	1, 2, B, C, D
Alisa	1, 2	1, 2, A, B, D	1, 2, B, C, D
Lavonn	1, 2	1, 2, B	1, A, B, C, D
Jazelle	2	1, 2, D	2, B, D
Amy	1, 2	1, 2, D	
Catrina	2	2, A, B	1, 2, A, B, C
Yevette	1, 2	1, 2, B, D	2, B, C, D
Shyla	1, 2	1, 2, B	
Donna	1	A	1, 2, B
Jewel	1, 2	1, 2, D	
Patricia	1		

Note. Naturalistic ways girls evaluated scientific studies included (1) evaluating quantity of information provided or (2) identifying the importance of the study's claims for themselves and others. Scientific ways girls evaluated scientific studies were based on (A) the study purpose, (B) the sample and methods used, (C) how data were represented as evidence, or (D) how claims were based on evidence. LS = Lunchtime Science; LSI = LS Unit 1; LSII = LS Unit 2.

describe "how and why" the girls built these scientific explanations—individually and collectively—using different forms of critique.

Engagement in Science Identity Work—Collective Focus

To identify episodes of PDE for the group, I coded segments of talk during LS that were marked as (a) collective engagement—instances of relationships, such as overlapping talk, adding to someone else's talk, negotiating for the floor, completing each other's sentences, and complimenting or crediting others; (b) disciplinary engagement—relating to scientific explanations and how scientific knowledge was constructed; and (c) productive engagement—students used increasingly sophisticated arguments over time to make new connections among scientific ideas (Engle & Conant, 2002), challenge others' perspectives and claims, coordinate theories with evidence (Herrenkohl & Guerra, 1998), involve a high level of monitoring comprehension of content, and generate authentic questions (Gamoran & Nystrand, 1992). Table 3 lists the 9 identified episodes of PDE across the 4 weeks of instruction and indicates ways in which girls built ideas across days. Instructors' contributions aligned with the design principles are also included.

TABLE 3
Episodes of PDE During LS

Episode		*Task*	*Type of Productivity in PDE Episode (Engle & Conant, 2002)*	*Instructors' Contributions*
1.	How does smoking affect a fetus? Is second-hand smoke worse than first-hand smoke for a fetus?[a] *(Unit 1, Days 1 and 3)*	Day 1: Role playing, as if talking to a friend who is pregnant and drinking Day 3: Sharing content from newspaper articles	*Made new connections among ideas. 7 girls participated substantively.* On Day 1 the girls raised a question about smoking, and on Day 3 they debated the impact of first-hand and second-hand smoking on a fetus. They reasoned with the concentration of chemicals, shared information from articles and television programs, compared smoking to their knowledge of rat poison and cocaine, and wondered why the government would allow poisons in cigarettes.	Instructors revoiced and tossed back girls' questions to the larger group, suggested uncertainty of own their knowledge, shared resources about chemicals in cigarettes, and questioned girls' sources of evidence.
2.	Where does the lead in our water come from? How is it harmful?[a] *(Unit 1, Days 3 and 8)*	Day 3: Sharing content from newspaper articles Day 8: Sharing content from and scientific critiques of newspaper articles	*Made new connections among ideas and increased the sophistication of arguments. 8 girls participated substantively.* On Day 3 one girl reported findings from a study and the group speculated about how lead ends up in drinking water, shared stories of tap water, and questioned the impact of filtering water. On Day 8 one girl began by reporting findings from a study, a few girls questioned their own risk of lead poisoning, then several girls prompted one another to return to articles for more information on how lead gets into the water and effects a developing fetus; they then compared this to fetal alcohol syndrome (a topic from Day 6).	Instructors invited girls to share findings from newspaper articles, revoiced ideas and questions, and distributed more articles on lead to help address questions raised. On Day 8 instructors' participation was minimal.

3.	How could our study be improved? How should we study fish, and what will we learn? *(Unit 1, Days 4 and 5)*	Day 4: Evaluating an inquiry from the previous year, then designing questions and methods for new inquiry Day 5: Making predictions	*Designed a study to satisfy a goal. 9 girls participated substantively.* Second-year girls critiqued a study design from the previous year in a whole-group conversation, then in small groups the girls designed studies; they considered variables and trials, debated the humane treatment of animals, related stories of family members who were pregnant or who ingested poison/alcohol and family members who use pesticides, returned to the idea of lead poisoning from Day 3, and designed data tables with indicators for fish development. On Day 5 the girls returned to some of the same stories and identified measurement outcomes while considering chemical compositions of alcohol and pesticides.	Instructors asked second-year girls to critique a study done the previous year, provided a list of materials, shared resources about fish development, pressed girls to relate content from the previous day about diffusion, and encouraged the girls to make connections between human and fish development.
4.	How will chemicals impact fetal development? *(Unit 1, Day 7)*	Day 7: Revising content and designing a model of how chemicals/nutrients diffuse	*Made new connections among ideas. 10 girls participated substantively.* Girls drew models, and although the task just asked them to think about the effects of alcohol they also considered the diffusion of lead and pesticides; they differentiated among ingesting, breathing, and absorbing chemicals and which chemicals could cross a placental barrier (a topic from Day 6 with a midwifery professor).	Instructors pressed girls to consider how chemicals reached a fetus, codeveloped a model of diffusion, and provided resources on the role of the placenta.
5.	What are some sources of pollution in your life? *(Unit 2, Day 1)*	Day 1: Eliciting prior knowledge about environmental pollution and effects on family members	*Designed something to satisfy a goal. 12 girls participated substantively.* Girls drew and shared models of environmental pollution, shared stories of riding the city and school bus and of mercury pollution (a topic from a different class), and considered how smoke concentration differs outdoors versus indoors. Many girls raised questions about how sources of pollution affected their lives.	Instructors encouraged all girls to share ideas, prompted girls to think about effects on family members, and revoiced conversations about triggers important to asthma. The girls' teacher shared a story about her asthma.

(*Continued*)

TABLE 3
(*Continued*)

Episode		*Task*	*Type of Productivity in PDE Episode (Engle & Conant, 2002)*	*Instructors' Contributions*
6.	What is asthma, and what triggers asthma? *(Unit 2, Days 2 and 3)*	Day 2: Building a content base for how asthma works and environmental effects with a doctor and with a teacher who has asthma Day 3: Role playing doctors and patients with case studies of friends and family members with asthma.	*Raised new disciplinary questions. 12 girls participated substantively.* On Day 2 the girls asked several "what if" questions to the internal medicine doctor and their teacher, shared stories of family members with allergies and asthma, debated through the telling of family stories the correlation between asthma and allergies, further differentiated between indoor and outdoor triggers, and raised the question about inheritance. On Day 3 the girls applied their new knowledge in a role playing situation and prompted one another to share more information.	Instructors revoiced girls' scientific questions and partial explanations, asked girls to restate ideas, tossed questions directed at the instructors back to the larger group, elicited knowledge from prior experiences, and asked the girls to elaborate their ideas. The teacher and doctor fielded questions about asthma and shared resources about unobservable concepts.

8.	What might happen in our study? Can Tara's asthma be cured? Is asthma genetic?[a] *(Unit 2, Days 4 and 6)*	Day 4: Hypothesizing why asthma is on the rise in Central District Day 6: Designing a survey with questions the girls are interested in answering.	*Made new connections among ideas. 11 girls participated substantively.* On Day 4 the girls continued to differentiate between triggers and causes of asthma and investigated the influence of genetics versus environmental factors on asthma (topics from Days 2, 3, and 4). On Day 6 the girls questioned the purpose of their study, offered potential survey questions after sharing and challenging one another's stories of family members with asthma, pressed one another to clarify the wording on the survey, and raised equity-related questions about prevention versus treatment of asthma in the inner city.	Instructors used girls' ideas from the conversation and conversations from the previous days to pose potential survey questions and answered questions about mechanisms for unobservable phenomenon.
9.	Did they forget about race?[a] *(Unit 2, Day 4)*	Day 4: Building the concept of how to evaluate graphs through examining trends in asthma cases	*Made new connections among ideas. 13 girls participated substantively.* The girls questioned others about how they were interpreting data, raised the question about how race was studied and represented in charts, and made references to one another's ethnicities in comparison to the study at hand.	Instructors asked girls to examine disaggregated data by race, gender, age, and so on, and encouraged the girls to critique scientific studies using the framework.

(*Continued*)

TABLE 3
(*Continued*)

Episode		*Task*	*Type of Productivity in PDE Episode (Engle & Conant, 2002)*	*Instructors' Contributions*
10.	What advice would we give? *(Unit 2, Day 10)*	Day 10: Presenting findings from inquiry and relevant scientific studies while giving advice to a hypothetical friend from a case study	*Increased the sophistication of arguments. 9 girls participated substantively.* By Day 10 the girls created sophisticated arguments about what triggered and caused asthma, compared this to findings from articles they read, rallied information about unobservable mechanisms, and addressed unanswered questions from Days 2, 3, and 4. It is important to note that they also challenged one another on how they were interpreting data from their inquiry (an advancement from Day 4 and the first LS unit); some second-year girls described limitations in their understandings and positioned younger girls as the knowledge authority.	Instructors kept time so that each group would have a chance to talk and played a minor role in asking questions to girls during presentations. Occasionally instructors asked girls to juxtapose ideas from different groups, but for the most part the girls did this.

Note. PDE = productive disciplinary engagement; LS = Lunchtime Science.
[a]Student-initiated discussion.

FINDINGS

What was most striking about the girls' talk in LS was the way they imagined interacting with others in relation to the content they learned. They described the importance of learning the material so that they could support other girls in the LS group and so that they could eventually become better mothers, friends, and family members. For most girls, their narratives about LS paralleled their stories of engaging in other contexts—about the few times they felt engaged in science class or in a favorite class, or the more frequent times they felt engaged in an extracurricular context. Across these contexts, the girls described opportunities to tap into and build on ideas about themselves and their future selves. They also described processes that supported this work, such as sharing their opinions with others and having others respond to their ideas, connecting with others, and understanding others' ideas and stories. These processes are known to be critical for refining ideas about one's self (Sfard & Prusak, 2005).

Based on the data, four engagement patterns supported the girls in learning about themselves and science. Each pattern had a different profile with respect to how narratives were used as resources, how the girls were positioned as competent learners, and what type of learning occurred. The patterns are named for the identity talk the girls engaged in: (1) gleaning content for outside worlds, (2) supporting the group, (3) negotiating stories across worlds, and (4) critiquing science. The first pattern best described the *individual* engagement that most girls engaged in during LS. The second, third, and fourth patterns were *collective* forms of engagement coconstructed by groups of girls.

These forms of engagement stood in sharp contrast to the girls' participation in their regular science classes. In the 14 hr I observed the girls in their science classrooms in the weeks leading up to LS, they each only spent 10 min on average talking about science concepts. In some cases these minutes were spent doing a presentation to the class; in others they were spent in small-group interactions in which the girls sought correct answers from texts or teachers. The four patterns, described in detail here, may serve as fruitful conceptual frames for future research and design of science learning environments.

Individual Engagement: Gleaning Content for Outside Worlds

To understand the first pattern of engagement in LS, it is important to examine historical patterns of engagement for the girls as well as in-the-moment connections they drew between their lived experiences outside of school and LS. In this section I begin with a case study of Alisa, who, unlike most girls in LS, believed that she was a scientist (under certain conditions) but who, like most of the girls (11 of the 17), worked on developing a narrative of caring for others and teaching others. These narratives—of being a scientist and teaching others—were important

to the ways in which Alisa and several other girls engaged in gleaning content for themselves and significant others across multiple settings.

Alisa. In her science classes Alisa was typically quiet. Her biology teacher described having to prod Alisa to participate. She did not interact with peers during class, and she only interacted with the teacher after class to ask about making up assignments.

Although Alisa struggled to pass her high school science classes, she described being engaged and even "feeling like a scientist" when doing experiments. When asked to identify a time she felt engaged in science, she told stories of manipulating variables and studying outcomes in middle school. In one case she described having the opportunity to hypothetically mate two dogs and determine possible phenotypes. She described being interested in traits that were not present in parents but that appeared in the offspring. An important part of her story was that she used what she learned about Punnett squares to teach her younger sister, who "needs my help. I can help her 'cause I understand it; you know A-A-B-B and the way you have to add it up in the boxes." Similarly, when she described a time she felt engaged in ecology the following year, she told a story about the time her class went to teach her brother's second-grade class about hazardous waste. She learned about chemicals frequently dumped into the ocean but said that the best part of the experience was "teaching them new stuff." After she shared the presentation with her mother, their family stopped using bleach as a cleaning agent around the house.

Alisa viewed herself as someone who helped her family by "passing along information." But she also regularly worked on teaching her brother and cousin to read. Alisa described being most engaged in reading books about and by African Americans. She believed this provided insight into being an "urban teen" and a "daughter in a single-parent family" and gave her information to prove to others that "African Americans can do something, and I wanted to prove that I can do something. I can graduate." Although some dimensions of these complex stories of engagement were left untapped by LS—particularly Alisa's developing ideas of being African American—LS did tap historical narratives of helping and teaching others and, to some extent, her ideas about being an urban teen. These narratives offered visions of "possible others" she might teach now or in the future. During the first LS unit she imagined teaching pregnant teenagers:

> I didn't know about caffeine, how it can increase your chance of low birth weight or miscarriage; I didn't know that at all. I knew about lead. I didn't know vitamin C . . . that you can die if you don't have enough of it. We can talk to pregnant women about it because there's a lot of teenagers becoming pregnant these days. I would give them . . . make them aware about stuff. Because a lot of teens drink coffee, too. (post–LS Unit 1 interview)

Not surprisingly, 2 years later Alisa recounted having the opportunity to share some information: Her coworker at McDonalds was pregnant, and Alisa talked to her about the importance of folic acid early in one's pregnancy. Other girls also recounted "short stories" of talking with pregnant friends about taking prenatal vitamins, with family members about younger siblings who had asthma, and in one case with a total stranger who was near term in her pregnancy about not drinking a large Starbucks coffee. What appeared to be most important for all of the girls, regardless of the action taken outside of LS, was the act of imagining conversations with others and becoming equipped with information they could potentially share.

More than just imagining interactions with others and simply using a "content filter" during LS, Alisa and two other girls (Sandra and Tia) *designed experiments* that would provide targeted information for family members. In Alisa's case, she wanted to better understand her cousin's asthma, both causes and triggers. She reflected on the root of her inquiry:

> I didn't know that you can get asthma from having your stove open. 'Cause we do that. And I didn't know that you can get it from mold. I didn't know it was that severe as it is. That you can, like, die from it. And there's no cure; I didn't know that either. I have a little cousin—she's four—she has asthma but we don't know where she got it from. So, we can find out what she does to see where she could have got it from. 'Cause asthma doesn't run in my family. (post–LS Unit 2 interview)

Productive Engagement in Science Discourse. In most cases the girls' imagining was personal and not shared in the public space. The content they appropriated took the form of facts, percentages, and correlations but not elaborated explanations. In some cases the girls made public who they were appropriating information for, and the group worked on the science of these stories collectively (as described in Pattern 3), and these instances supported the critique and construction of science ideas.

Narrative Resources. Two types of narratives—*helping and teaching others* and *designing experiments*—were important to how the girls gathered content for outside worlds (see Figure 1). In these roles, the girls often took the position of being a knowledgeable other, drawing on ideas from one context of their lives to help others in another. But not all of the girls leaned on historical narratives of helping and teaching others as a motivation for acquiring new content. Lavonn, Jazelle, Catrina, Yevette, and Donna (girls in Groups III and IV) imagined acquiring information for others without having built extensive narratives around helping and teaching others. It may be the case that LS, unlike other learning experiences in the girls' lives, afforded the opportunity to try on new identities around being an informed health advocate for friends and family members.

		Historical narrative resources (categories from interview data about historical engagement across multiple contexts)		**Engagement in gleaning content for outside worlds** (categories from LS discourse data and interview data about participation in LS)		
		Helping take care of others (including animals/environment*) and teaching others	Designing experiments	Reading and listening to others for self, future self, or others during LS	Designing studies during LS for self, future self, or others	Short stories of teaching others/taking action outside LS
GROUP I. Insiders in science and school	Tara	Learning how to help animals and become a wildlife biologist*	Designing experiments with animals	For future self: Learning more about working with animals (LSI)	For future self: to design healthy environments to care for fish (LSI)	
	Kiana	Learning to care for animals with dad, a zookeeper* Teaching reading to children and giving back to her community		For future self: Knowing more to take care of others in the African American community (LSII) and her children someday (LSI)		
GROUP II. Insiders in school science, becoming insiders in school	Kalisha	Learning about health issues for friends/team mates Teaching sports and others in remedial science class		For self/Tara: Learning about taking care of herself and a new friend, Tara, who plays sports and has asthma (LSII)		For friends/self: Helped friends become more knowledgeable (LSI/II), got tested for asthma (LSII)
	Sandra	Learning how to teach and persuade others in debate	Conducting her own research	For future self: Trying on idea of becoming a doctor (LSI)	For sister: To assess the impact of smoking on asthma (LSII)	For others: Talked to a stranger about not drinking caffeine while pregnant (LSI)
	Eloisa	Learning about caring for the environment*	Designing authentic experiments	For future self: Learning about caring for herself now and becoming a mom (LSI)		For self: Started taking vitamins (LSI)
	Kira	Learning about becoming a doctor and caring for others with mom, a nurse	Doing experiments	For future self: Learning information she can teach others as a doctor (LSII)		
	Tia	Learning content for becoming a doctor/caring for others	Conducting her own labs (in Africa as well)	For future self: Learning to be healthy, trying on idea of becoming a mom and a doctor (LSI/LSII)	For self and family: To assess the impact of chemicals (LSI), the influence of genetics vs. environment (LSII)	
	Alisa	Teaching reading and science to younger siblings	Designing experiments	For future self, friends, and family: Learning for friends, family and becoming a mom (LSI/II)	For family: To assess the impact of mold on asthma (LSII)	For coworker: Talked with coworker about prenatal vitamins (LSI)
GROUP III. Becoming insiders in school	Lavonn	Helping young children in her church group		For future self: Learning information for having children someday (LSI), learning information for her community (LSII)		
	Jazelle	Past narrative: Learning about being a veterinarian and caring for animals*		For self and family: Learning about how to care for her body and her family (LSI/II)		For family: Talked with family about decreasing triggers for asthma (LSII)
	Amy	Teaching reading to children		For self: Learning about taking care of her self (LSI)		

FIGURE 1 Narrative resources and discursive participation that supported Pattern 1 (gleaning content for outside worlds). Some girls were able to build on their historical narratives, others were not. Time lines (lines with dots on each end) connect the girls' historical narrative resources (as indicated through interview data) with their engagement in LS for the purpose of gleaning content knowledge. Two themes important for the gleaning of content for most girls are traced: helping and teaching others (light shading) and designing experiments (dark shading). LS = Lunchtime Science; LSI = LS Unit 1; LSII = LS Unit 2. *(Continued)*

	Catrina	Emerging narrative: Becoming a teacher/principal	For future self and teammates: Learning for "becoming a mom"(LSI),learning about asthma for teammates/trying on idea of taking action to reduce pollution (LSII)	For friend: Pressed a friend to consider healthy choices while pregnant (LSI)
GROUP IV. Becoming outsiders	Yevette	Helping take care of young children in her church group and raising donations for children in Africa	For self and friends: Learning content for taking care of others' health needs (LSI and II), questioning asthma researchers about her health status (LSII)	
	Shyla			For self: Used topic for a credit retrieval project (LSI)
	Donna		For self, family, friends: Learning for her pregnant sister/her future self (LSI), learning information to "pass along"to family/friends (LSII)	
GROUP V. Outsiders	Jewel	Teaching dance to children		
	Patricia			

FIGURE 1 (Continued)

The other historical narrative that supported gleaning content for outside worlds was associated with *designing experiments*—a remarkable notion in itself given the girls' histories of academic performance in science. Four of the five girls (Tara, Sandra, Tia, and Alisa in Groups I and II) with histories of developing identities around seeing themselves as individuals who directed classroom experiments described how their LS experiments were fueled by unanswered health-related questions in their families.

For the girls most marginalized by school (Groups IV and V), other historical narratives countered activities in LS. For Shyla, Patricia, and Jewel, LS did not provide new material or new possible images for ways of interacting with others. Shyla and Patricia described themselves as "not nature people," and Jewel described herself as "not wanting to be a mom." They also described LS as being too much like school. These counternarratives positioned the girls as outsiders to the group and prevented the type of productive imagining that came more easily to the other girls.

Positioning. The LS curriculum offered some support for imagining oneself as helping and teaching others. At the beginning and throughout each unit, the girls were prompted to think about how they would interact with others in a hypothetical case study. For LS Unit 1, they imagined giving advice to a young woman who was drinking during pregnancy, and for the second unit they imagined giving advice to three young women with asthmatic symptoms in different living conditions. In addition to bookending the curriculum with giving advice to hypothetical friends, the instructors constantly invited the girls to share their knowledge. In LS Unit 2, for example, the girls shared ideas on where they thought air pollution in their community came from and how it was relevant to their families. With stories of local interactions in mind, the instructors helped target readings and tailor investigations to specific topics for each girl. These moves most likely supported the girls not only in acquiring new facts but in approximating their imagined role of informed expert for others. These identities and roles not only were important for gleaning facts for the people they cared about outside of LS but also became vital to developing discursive identities within LS and to supporting instances of PDE, described in the next three sections.

Collective Engagement: Supporting the Group

The girls' *collective engagement* provides further insight into how sociohistorical narratives were important to learning during LS. This second engagement pattern is similar to the first in that the girls drew on narratives of helping and teaching others yet different because the girls enacted these identities *within* the group. When interviewed about what best supported their learning, the girls did not talk about the importance of case studies, instructional moves, or material activities;

rather, most described the importance of having opportunities to listen to others, to share opinions, and to be heard. They also described taking on roles of teachers and helpers *to other members in LS.* These are ingredients for the perspective taking needed to support the development of a group identity but also for the negotiation of one's role within a group. And, as it turns out, these were also the ingredients needed to negotiate science content in productive ways.

Not surprisingly, the girls who described working on narratives of helping and teaching others during extracurricular activities or in their favorite subjects also described themselves as helpful to the learning of others in the LS group. Alisa, for example, envisioned herself as a "helper" to freshmen entering the LS group during the second year: "I'll make sure they understand [the negative effects of alcohol during pregnancy] . . . so they can help people—younger people" (pre-LS interview). She similarly described her role in the group following both sessions: "I was helpful. Because I gave good information about the articles and they didn't know that information. So I gave them something new, so they can tell people and then those people can tell other people" (post–LS Unit 1 interview). Not only did she help others, but others supported her learning: "Most of the people put in their own thought of what the answer was, so I understand it more" (post–LS Unit 1 interview). She contrasted this with her experience in her regular science class:

> We do experiments, but we don't talk because we get separated, and if we have questions we ask the teacher. [LS] was more talking and communicating instead of taking notes that I wouldn't read anyway. But if you talk about the subject and listen to what others say, it will help you out a lot. That's the way I learn. They were listening, and that made me want to keep talking. (LS member check 2 years later)

Some girls became advocates for particular science ideas within the group, repeatedly teaching others. Lavonn described herself as a talker and a listener in the group and believed that one of the key ideas she brought to the group was a description of how pesticides affect fish through contaminated groundwater. She read an article and then took several opportunities to explain how pesticides travel through the water cycle and how this relates to diffusion of minerals across a placenta. Other girls would ask questions to track her thinking. Yevette similarly became an advocate and resource for claims around lung capacity and potential differences in asthmatic conditions for women and men.

The girls described seven ways in which they supported the group and positioned themselves and others as active participants in LS: (a) asking a clarifying question, (b) revoicing others' ideas, (c) referencing another girl's idea, (d) telling a personal story, (e) giving a personal opinion based on prior experiences, (f) reporting findings from a scientific study, and (g) coteaching and keeping the group on task. Some of these forms of support were similar to the ways in which

girls described interacting with friends and family outside of school (i.e., giving personal opinions), and some appeared unique to LS (i.e., coteaching). None was similar to interactions in their regular science classrooms. These discursive moves helped reify the girls' individual identities as helpers and teachers within the context of LS.

Productive Engagement in Science Discourse. What was most interesting was when girls with similar historical narratives about helping and teaching others collectively used these discursive moves. In these instances, the girls moved beyond reporting ideas and supported the collective development of new constructs, study designs, and disciplinary questions.

Alisa and Kiana, for example, both had histories of engaging in teaching younger children. In terms of self-designated identities in LS, Kiana frequently assumed a position as coteacher. She was 1 year older than most of girls, and in our group conversations Kiana typically elaborated on the teachers' comments by adding an idea or retelling instructions. In this example, Kiana, through feedback, helped Alisa describe asthma:

Author: So let's figure out what we already know and come up with a statement.
Alisa: That you can't breathe and you die.
Kiana: That your airways close.
Alisa: Your airways close and you die.
Kiana: No.
Alisa: Your airways close and you can't breathe.
Kiana: Yeah. (LS Unit 2, Day 2)

The girls were then asked to participate in a role play in which a doctor had to work with an asthmatic patient and her friend to identify triggers specific to that person's case. In the following example Alisa plays the doctor, Eloisa the patient, and Kiana the friend; the scenario is that the patient and her friend were exercising outside during the summertime, and the friend noticed the patient wheezing. As part of the role play, the girls were asked to apply their knowledge from a conversation with a doctor of internal medicine the previous day. Table 4 shows a part of a larger conversation that helped the girls better explain observable features of asthma (such as "spasms") in relation to unobservable mechanisms that trigger asthma. The fact that both Kiana and Alisa care about teaching others becomes part of their discourse and their learning.

In this episode, Alisa is guided to explain her current understanding of asthma. She takes her assigned helping role seriously, despite others' playfulness (Huber et al., 2003), and moves beyond what Kiana prepared her to say earlier. For example, she connects the idea that asthma is not curable to a lack of knowledge in the scientific community. However, Kiana continues to shape how Alisa teaches by

TABLE 4
Transcript From Lunchtime Science Exemplifying How the Girls Supported the Group (Unit 2, Day 3)

Kiana: Okay, you guys explain, you've gotta explain to me and Eloisa.	Kiana coteaches
Alisa: You have to ask questions. . . . One thing is that when you have asthma—	
Kiana: Um-hum.	
Alisa: When you have asthma, your lung slows and it is hard for you to breathe, and your lungs . . . your airways close, and it makes it difficult for you to breathe.	Alisa provides a scientific explanation
Eloisa: So it is a disease or something?	Eloisa asks a clarifying question
Alisa: Yes, asthma is a disease. You can get it and it can go away. But it is not really curable, because, like, scientists don't really know what it is and how people get it.	
Kiana: Okay, what triggers her spasms?	Kiana directs the conversation with a scientific question
Alisa: From what you told me . . .	
Alisa adds to the scientific explanation	
Kiana: What triggers her asthma *outside?*	
Alisa: Cause she is running outside in the summertime, which is hot and humid, and it has a lot of pollen, so that could be, like, why she is breathing so hard when running.	Eloisa teases Alisa with a clarifying question
Eloisa: So that means I have to be in a wheelchair or something?	Alisa rephrases scientific explanation
Alisa: No. If you want to run, you can go to the gym or wait until the summer is over, you know, which probably means the pollen is getting to you, which makes it hard for you to breathe.	
Eloisa: Oh, okay.	
Alisa [eating a carrot]: Anything else?	
Eloisa: What am I going to take?	Eloisa asks a clarifying question
Alisa: What I have prescribed for you is . . . I don't really know how to pronounce it.	
Eloisa [laughing]: You have a PhD. [to Alisa, *sic* MD]!	Eloisa teases Alisa Alisa tries on "doctor talk"
Alisa [talking over laughter]: Since you are already breathing hard it is going to help you prevent it; it starts with a *b. Bronchodilator*—I'll write it down for you. Well, then you will come back in here and we will run some tests and probably give you . . . what's it called . . . but it is a breathing machine that you take home, like if your asthma is really getting bad, like, it is getting worse and worse [laughter]. If it is getting worse and worse, then you can take it home and use it right before you go to sleep.	
Kiana: Thank you, Dr. Carver. Cool.	Kiana affirms Alisa's participation

pressing the connection between outdoor environmental triggers and symptoms of asthma, an idea she continues to press herself and others on for the remainder of the unit. It is noticeable, however, that this conversation seems to be more productive for Alisa and Kiana than Eloisa: There is little evidence that Eloisa makes new connections among ideas. She has not imagined whom she will appropriate content for (as Alisa does), does not take up a role as coteacher (as Kiana does), and does not have strong themes for helping and teaching others in her historical narratives (as Alisa and Kiana do).

In this and other generative episodes, what kept the conversations flowing were multiple girls using the seven forms of "supporting the group discourse." Almost all girls, with the exception of Shyla, Jewel, and Patricia, used these forms of participation in multiple episodes of productive disciplinary discourse. LS thus offered a way for the girls to take up the very discourses that were missing in their classrooms. To understand why, it is important to examine not only how the girls drew on similar historical narratives but how identities were collectively developed rather than individually constructed during LS.

Narrative Resources. The prevalence of the "supporting the group" forms of discourse across episodes and girls suggests that something more than historical narratives about helping and teaching others was at play. Most of the girls who participated in LS developed a sense of belonging to the group and referred to themselves as "we" in group conversations and interviews. They viewed themselves as members of the LS group who "shared opinions." However, the two girls who were outsiders to LS and to school (Patricia and Jewel, Group V) did not participate as often in LS as other girls and described not "feeling included." Although this is most likely different from "feeling excluded" by classmates, the teacher, and in some cases the topic under study in their regular science classes, not being included in LS suggests that membership, or seeing oneself as part of a group, was a prerequisite for meaningful engagement in learning in LS (Newmann et al., 1992).

Positioning. Our attempts to directly position girls as knowledgeable others only supported "one-off" conversations, whereas when the girls positioned one another as knowledgeable others, generative dialogue ensued. We used classic strategies of jigsaws to support the girls in sharing their new understandings (see Cohen & Lotan, 1995, for ideas about positioning and status treatments). The girls were encouraged to specialize in a particular dimension of the scientific explanation and read articles and report findings to others. Furthermore, we deferred questions to students who were developing expertise in a topic whenever possible. This affirmation by instructors and peers might have supported girls like Lavonn and Yevette in positioning themselves as knowledgeable about particular science ideas (see Engle, 2012).

More important than the instructors' discursive moves were the platforms we offered for girls to interact with one another. In the previous example, the structured task of role playing and assuming teaching roles provided such a context, but allowing time for the girls to unpack ideas they put on the table was equally important. In other PDE episodes, we gave the girls time to reason through their self-generated questions and validate claims, such as why lead in drinking water was harmful (see Table 3). In this capacity, the girls positioned one another and themselves as critical others and perhaps "significant narrators" (Sfard & Prusak, 2005, p. 18) who could potentially help one another revise narratives about themselves in LS and perhaps beyond.

The girls' discursive moves helped them author themselves as "helpful group members" and one another as thoughtful, competent participants. Taken together, the girls' narrative resources and positioning by peers supported the coalescing of the group, which was the basis for making new connections among ideas, designing investigations, and raising new disciplinary questions.

Collective Engagement: Negotiating Stories Across Worlds

The third pattern of engagement was less dependent on historical narratives and more dependent on how the girls' "everyday stories" were shared and worked on "in the moment" during LS. Although many girls shared personal stories about themselves, about people they cared for, and about the neighborhoods in which they lived, only some of these stories were taken up as a mode for learning scientific content. For the girls, taking up stories meant the difference between "tapping" their identities and using identities as a part of the social platform for creating new scientific stories. When stories were challenged and unpacked, they became part of the social discourse that directed learning in LS.

Productive Engagement in Science Discourse. What appeared to be critical for instances of PDE was the challenging of the girls' stories, not just the sharing. The girls examined the congruence of stories on the public platform with findings from newspaper articles and from other girls' stories. In the following conversation, four girls work in a small group to design questions for a survey they will eventually give to students in the school about triggers and causes of asthma. Three girls share stories about people with asthma, and two of these stories are taken up to produce a question that forms the basis of a week-long inquiry. The girls also help Tara question whether one can "grow out of" asthma. This conversation began with Tara and Kalisha quizzing each other about how much they knew about asthma, then moved to them teasing each other about being winded when playing sports. Sandra had participated in LS the previous year with Tara and Kalisha; Tia was a year younger. What is

most important in this episode is the way in which the girls interject and examine their own and others' stories. In so doing, they not only design questions for the survey but also work on an important distinction between triggers and causes of asthma.

As shown in Table 5, the girls use Tara and Tia's stories to make new connections among ideas, specifically that asthma is genetic but that it might also be caused by environmental factors. Yet the girls do more than just glean information for outside contexts (Pattern 1); by negotiating the content of the stories, they work on a scientific explanation underlying the stories. Their reasoning with stories became a part of their survey questions and ultimately part of their final projects. For their inquiry project, Tia and another girl examined data on the role of inheritance in causing asthma. Tara and another girl examined the role of exercise on asthma. Sandra, who briefly shared the story about her sister and allergies and posed seemingly unrelated questions about smoking, then went on to design an investigation into the influence of smoking on asthma rates. In an interview, she shared more of this story. Her concern was that her sister had asthma because they lived in a house with smokers. Although her story was somewhat more private, she publicly made a case for studying smoking. She and Kalisha—who also lived with smokers and wondered whether she herself had asthma—chose to examine data related to smoking and asthma.

Narrative Resources. This pattern of engagement involved substantive personal stories that became the object of scrutiny. Stories were transformed, or hybridized, for the LS context in a way that supported the girls in consuming and producing scientific knowledge in new ways. This was the case in most episodes of PDE but was not the case for all girls. The stories of the girls most marginalized by school (in Groups IV and V) were not taken up on the social plane. These girls were less likely to participate in LS, but when they did share everyday stories it was difficult for these girls and the instructors to infer how their stories were relevant to the conversation. Although there were missed opportunities for building science stories, the girls in Group IV did not see it this way. They maintained that sharing everyday stories was a way in which they were members in the group (Pattern 2).

Positioning. In the previous example, our intention was to encourage each girl to include aspects of her stories and interests in the survey we were developing. In fact the girls used one another to elaborate their stories and generate authentic and worthwhile scientific questions. More than just highlighting their shared stories, the girls layered everyday narratives on top of one another (Huber et al., 2003) and examined discrepancies among one another's stories and the readings they did in LS.

TABLE 5
Transcript From Lunchtime Science Exemplifying Negotiating Stories Across Figured Worlds (Unit 2, Day 6)

Author: So are you ready to start designing your own questions for the survey?	
Tara: Can stress trigger asthma?	
Kalisha [quizzing Tara]: What happens to the lungs when you get asthma?	
Tara [directed toward Kalisha, a basketball player]: The little pipes or airways get blocked and, well, you get it when you take out a basketball	Interjecting one's story as a knowledge claim
Kalisha: Hey, that is not fair.	
Tia [quizzing Tara]: Do you know the basics of asthma?	
Tara: Well you don't sneeze all the time; actually, I do—I did cough a lot. But I don't have it anymore.	Challenging Tara's story
Kalisha: You kinda do. You have off and on asthma.	
Tara: How do you know?	
Kalisha: 'Cause you get it about now.	Interjecting a story as supporting evidence
Tara: Those are allergies.	
Sandra: My sister has allergies, but she does not have asthma.	
Kalisha: Your allergies trigger your asthma.	Unpacking Tara's story further—raising the question of whether or not asthma is curable
Tara: Not me.	
Kalisha: Yes, you.	
Tara: I get it in the fall after allergies are over.	
Kalisha: But that is soccer season.	
Tara: Exactly, 'cause I run in all seasons, but I get it in the fall—get it?	Taking her story off the table
Kalisha: No.	
Tara: Well that is too bad, let's move on.	
Author: So what will we learn by asking these questions?	Interjecting a new story to express interest in gleaning information (Pattern 1)
Sandra: We will be able to tell what everybody knows about asthma? Wait, what's the goal of our survey? I know I want to do the survey because I want to find out if more asthma kids come from homes who have more smokers and smoke in the house.	
Author: So let's write down some of our questions.	
Tara: Does smoke cause or affect asthma?	Fleshing out how to investigate Sandra's story
Sandra: Do you live in a household where somebody smokes?	
Kalisha: Any kind of smoke?	
Sandra: Or how long?	
Tia: Or how long have you been around smokers?	
Kalisha: I have been around smoke my whole life.	
Tia: I know this family with four kids, and one has asthma and the other three do, and it is inherited from the dad's side. And he doesn't smoke.	Interjecting a new story as contradictory evidence—raising a question about the genetic, not just environmental basis
Kalisha: It's genetic?	
Tia: He has one son from a different mother and three from another mother.	
Sandra: So they are like halves.	

(*Continued*)

TABLE 5
(*Continued*)

Tia: And the dad has asthma, and the grandmother has it.	Putting her (Tara's) story back on the table as supporting evidence
Tara: On the dad's side? Yeah. Okay. I have asthma. My mom has asthma, and she got it from her dad.	
Kalisha: Wow! It's genetic. Or it is, like, both?	
Author: This is what we will be able to find out from our survey.	
Tia: So we should ask, does it run in your family?	Designing questions to investigate Sandra, Tara, and Tia's stories
Kalisha: Should we narrow it down a bit? There's so many things that might be the cause of it. I don't want to be asking them so many questions. Like, do your best friend's auntie have it? Couldn't we just narrow it down to three specific questions? 'Cause I just want to know if smokers get it more, and people who has parents who smoke. That's it.	
Author [questioning Tara about her asthma]: Do you want to ask a question about exercise or about if they grew out of it? Or the season people get it?	Putting Tara's story on the table
Tara: I get it once a year.	
Sandra: So is it triggered by allergies?	Unpacking Tara's story further—once again raising the question of whether or not asthma is curable
Tara: No, it is triggered by exercise, because I run all through the summer.	
Sandra: So does that mean you necessarily grew out of it if you have it once a year?	
Tara: It has gotten better.	
Sandra: So technically you still have it.	
Tara: I don't know. Kalisha is right! I don't know if it is asthma or if I am out of shape. I don't know any more.	

Collective Engagement: Critiquing Science

Although most girls learned to critique study samples, methods, and claims, they were less likely to critique the purpose and the way data were represented as evidence. However, these forms of critique were possible when the girls interacted and leveraged shared narratives about race and "being represented" as well as narratives about "being scientists." In this section I bring issues of race to the forefront, as race remained the less tapped historical narrative during LS.

Productive Engagement in Science Discourse. Although race was not a planned topic of discussion in LS, it was a significant part of the stories of engagement girls told—both inside and outside of school. One, and only one, conversation during LS opened a door for the girls to reflect on race and scientific studies. The girls examined a report about asthma broken down by race, age, gender, and economic factors. A few of the girls took issue with the way in which race was treated in the report. The following episode comes from the first few minutes

of a whole-group discussion about a graph from the scientific study. Kalisha is Native American, and Sandra and Catrina are African American.

Catrina: It shows the overall prevalence of asthma, the age groups, and two different sexes . . .
Kalisha: They did it in 1995, and they had males and females, but they only did White and Black, which, like, messed it up, because there are more races than just White and Black.
Sandra: Not necessarily.
Kalisha: What?
Sandra: I said not necessarily.
Kalisha: Why?
Sandra: Because if they are just comparing White and Black, why would they test Native Americans, too?
Kalisha: Well, why they only gonna test White and Black . . .
Sandra: Maybe that's their study!
Kalisha: Maybe they should test other people!
Sandra: Don't be mad 'cause you wasn't tested [laughter].
Author: Sandra brings up a good point, because who were they testing? And maybe they didn't test everyone. And quite frankly, Kalisha is right too, because they did test everyone, and they didn't put it on the graph. So there is a problem here; they are not telling the whole story.
Sandra: I feel bad.
Author: No, it's a great point! (LS Unit 2, Day 4)

Not only does Kalisha critique the study based on the study participants, but Sandra questions the use of data as evidence. Kalisha and Sandra lay their personal stories, perhaps influenced by historical stories of exclusion, alongside the scientific story (Huber et al., 2003) and are able to do more than a perfunctory critique of the numbers of participants in a study. Although this conversation did not support other girls' critiques of data representations, it did support critiquing sampling strategies. Following this exchange, every group attended to race by critiquing which ethnicities were included in the study. Similarly, in the group interviews following this unit, each group of girls considered how they would sample across ethnicities when designing hypothetical studies.

Narrative Resources. There were several instances when girls who had built narratives around designing studies were able to challenge one another on the design of such studies and productively engage in epistemic forms of scientific critique. It seems problematic that 10 of the 17 girls had rich histories of building narratives around race and that there was only one conversation that allowed girls to construct a scientific story rooted in this narrative. Furthermore, if one looks back in time to the girls' stories of prior engagement in learning

about race, both inside and outside of school, one sees that the girls' stories of ethnic membership were richer than the dichotomy of being included/excluded discussed during LS. The girls told stories of being engaged in learning about famous African Americans and Japanese Americans or about "showing others" successful examples of members from their ethnic background. In this regard, there remains an open question about how instructors, particularly those from different racial backgrounds than the girls, support well-developed narratives about race as entry points to learning science.

Positioning. The curriculum provided opportunities for the critique of science investigations and scaffolds for using these forms of discourse; this was necessary but not sufficient. To make headway appropriating these forms, it appears critical to draw on common historical identities, as seen in Pattern 2. When the girls had the space to do this they challenged one another and challenged the way in which the discipline of science is known.

DISCUSSION

The girls' engagement in productive disciplinary discourse was less about the construction of disembodied science stories defined by curriculum and more about working on broader narratives of being girls, being ethnic minorities, and in some cases being scientists. During LS the girls built amalgams of everyday experience, science, and sociohistorical narratives as they engaged in identity work that was *broader than one individual, broader than one identity in one community,* and *broader than one generation.*

In this section, I begin with a summary of the four engagement patterns and the forms of learning afforded by each. I then unpack explanatory features underlying the four patterns and problematize current models used to characterize underserved girls' engagement in science learning. The aim is to contribute an identity-based theory for engagement in learning and to problematize PDE design principles for structured science learning experiences in and outside of school.

Four Distinct Patterns of Engagement

The fact that all of the girls in the study regularly drew on identity resources and that most engaged in PDE episodes in LS was not entirely surprising given that LS aimed to engage the girls in sense making about themselves inside and outside of science. Of interest, however, is the variety of ways this identity work was done. The first engagement pattern—gleaning content for outside worlds—was an individual endeavor whereby girls imagined others they could help or teach. This form of engagement better characterized the stories the girls retold about

their participation outside of school than the actual dialogue that occurred among girls in LS. All 17 girls described relating to LS in this way, with some taking more such action than others in their day-to-day lives. Other researchers have described this form of action taking as agency and identity development as individuals move ideas across communities and use acquired knowledge to shift positions (Barton & Tan, 2010).

The second, third, and fourth patterns—supporting the group, negotiating stories across worlds, and critiquing science—were collective and were characterized by productive disciplinary discourse episodes among groups of girls. For some groups, these conversations led individuals to pose new questions and engage in conversations in out-of-school contexts; but for the most part, PDE episodes helped the girls direct their resources toward *one another* in conversations in LS. In these instances, the girls did more than consume science facts; they produced shared science narratives. What follows is a discussion of how this coconstruction of shared science narratives occurred and how it was rooted in the girls' ongoing life work.

Challenging and Positioning One Another's Narratives

Although distinct in terms of aims, the three patterns that resulted in productive sense making (Patterns 2, 3, and 4) had important similarities in terms of positioning. The girls were positioned and took up positions as critical consumers and producers of knowledge (Barton & Tan, 2010). They were encouraged to pursue lines of inquiry that were of interest to them, and instructors assisted the girls in honing investigative questions. For example, we prompted Tara to investigate the relationship between asthma and exercise and Tia to investigate the influence of genetics on asthma. Other girls got wrapped up in these investigations so that over time critical masses of girls were researching these ideas. In recent years, several research studies have addressed the importance of positioning individuals and their ideas—as both a prerequisite condition and a concern requiring constant monitoring—to support learning about science and oneself (see Carlone et al., 2011; Esmonde, 2009; Kurth et al., 2002; Yamakawa et al., 2009). The findings from this study add to this literature by showing how the girls' positioning of one another supported the authoring of substantive science narratives.

Supportive challenging gave the girls the chance to further problematize the curriculum and develop genuine uncertainties that were not easily resolvable (Engle, 2012). There were two types of narratives the girls problematized: everyday stories and the curricular science story. In Pattern 3, the girls challenged everyday narratives, such as the genetic basis of asthma in the girls' families. In Patterns 2 and 4, the girls either challenged one another on the degree to which they understood the curricular story or challenged the curricular story itself (i.e., critiquing the way the curriculum failed to differentiate among triggers and causes

of asthma, and more broadly how scientists fail to construct studies that attend to race). Through supportive challenging, the girls held one another accountable to the building of the science story (Engle & Conant, 2002). Engle (2012) hypothesized the link between "accountable talk" (Michaels et al., 2008) and authority: As students account for how their ideas make sense, they will have increased authority over the content. This study shows that with support from the curriculum, girls not only can have greater command over science ideas but also critique epistemic features of that knowledge base. The bottom line, however, is that even more important than curriculum were the positions girls took up when challenging one another's ideas.

More than simply laying down one's story alongside curriculum (Huber et al., 2003), the girls challenged one another to build more comprehensive science stories by calling out portions of stories that seemed incomplete or by listening carefully for how they might add information to stories placed in the collective space. They reasoned with both the science story being built as well as their understanding of the narrator (e.g., knowing the sport activities a girl was involved in outside of LS or how a girl identified herself as African American or Native American). Challenging and supporting one another gave the girls the chance not just to elaborate science stories but to try on varied perspectives. A. L. Brown and Palincsar (1989) described how conflict and argumentation among peers are important to the development of ideas, but they hypothesized that these forms of discourse are part of a process of co-elaboration used to examine others' points of view. Thus, central to the elaboration of ideas and PDE were the girls' attempts to take into account varied perspectives. This added a nuanced crinkle to understanding positioning not just as "giving others the floor" but as an attempt to better understand oneself and others. From an identity perspective, challenging and pressing moves supported the ongoing development of narratives important not just in the community at hand but in narratives about race, health, and so on, that the girls were developing across communities. It is important to note that this suggests that for the girls, PDE was a byproduct of perspective taking and narrative development, not an end in and of itself.

Collective Identity Work With Common Historical Narratives

The girls' pressing and challenging moves were made possible by their engagement in *collective* identity work. Common themes across identity projects supported and sustained their conversations. The girls all were individually engaged in similar "ongoing" identity projects outside of the LS setting, such as "helping others" and, for two of the girls, "being experimenters." These historical narrative threads were reanimated as the girls enacted, shared, and challenged these narratives and built science narratives in LS. More than just cultivating relationships with people who shared similar "values of relationships and community"

(Basu & Barton, 2007, p. 483), and more than working on their historical narrative threads in parallel, the girls were able to discursively leverage their common identity projects to support PDE and the building of science narratives. In this way their identity work was *broader than one individual* and located not within but rather among individuals.

This mutual understanding among people, or intersubjectivity, is important for establishing a common ground for joint activity (Rogoff, 1998). Similarly, Nasir (2002) found that common histories helped build common definitions and visions of practices in dominos and basketball, which players used to structure their participation and identities as players. In this study, historical meant something different, as the girls "common histories" were derived not from one particular community of practice but across interactions with family and peers. Ultimately, their common historical narratives formed a common discursive basis for challenging one another's narratives and making sense of science stories.

The ways in which the girls collectively created science narratives composed of the curricular science narrative, everyday stories, and historical identities challenges researchers to think more broadly not only about collective forms of identity work but also about current learning and pedagogical models that blend different narrative forms. The role of narratives in classrooms—both drawing on narratives and building narratives—and the connection to learning is not well understood (Avraamidou & Osborne, 2009). Consensus from the learning sciences suggests that quality instructional opportunities begin with learners' experiences and build bridges to disciplinary ideas and ways of knowing (see Figure 2). In theory both sides of the bridge become stronger as students engage in disciplinary talk connected to their everyday lived experiences. Although in theory building

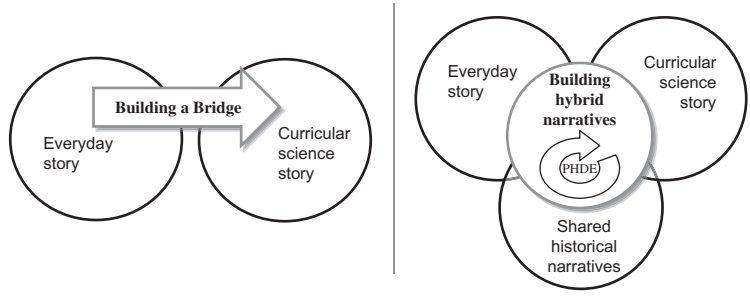

FIGURE 2 Although in theory the bridge model supports the idea of building on learners' lived experiences and everyday stories, in practice this typically translates to a unidirectional bridge that uses learners' everyday stories as "hooks" and aims toward the development of "the" curricular science story. The proposed hybrid narrative model provides a theoretical prototype of a "bridge" that supports the development of hybrid science narratives. PHDE = productive hybrid disciplinary engagement.

bridges between learners' funds of knowledge and the development of canonical understandings is a productive model, in practice this often proves difficult for teachers and instructors (Basu & Barton, 2007; Moje et al., 2001; Moll, Amanti, Neff, & González, 1992).

Observational studies from classrooms indicate that there are two ways in which often well-intentioned instruction can fail to build sturdy bridges. The left pillar of the bridge (see Figure 2) is weak when everyday stories are only treated as a "hook" to activate prior knowledge and do not fully account for the ways in which learners' stories are rooted in ongoing identity projects. Similarly, the arch of the bridge might be frail if portions of students' everyday stories are merely co-opted (Barton & Tan, 2010; Moje et al., 2001). Finally, it is often the case that the right-hand side of the bridge is privileged in classrooms; standard curriculum and instruction tend to emphasize arriving at a correct way of knowing canonical science rather than sense making and challenging curricular science stories. Too often, engagement is a considered a means to developing identities in but not beyond science.

This study suggests that it is important to understand "bridging in practice" not just for all learners but particularly for ethnic minority girls who are not succeeding in school science. When given opportunities to engage their personal narratives and life experiences that extend beyond school walls, and when science is open to critique rather than privileged over learners' experiences and ideas, ethnic minority girls can leverage common historical narratives to build hybrid narratives.

The hybrid model in Figure 2 can be thought of as bridge-building materials. In this model, discourses and identities are not distinct but rather integrated and hybridized. I refer to "hybrid science narratives" in the same sense that Barton, Tan, and Rivet (2008) referred to the construction of hybrid spaces, in which novel spaces and identities are the blending of science and out-of-school identities. Because the girls engaged in sense making beyond science, one might consider a different acronym, such as productive hybrid disciplinary engagement (PHDE). It is important to note that the model accounts for how the girls used multiple engagement patterns, at times relying on everyday stories as starting places (Pattern 3) and at other times building on narrative threads linked to identity work outside of LS (Patterns 1, 2, and 4).

Often people tend to think of tapping into students' ideas about who they would like to become someday as a way to enter into science conversations. Only one of the girls described how the activities in LS connected to her career aspirations. In some ways this might be problematic, but by working on common historical narrative projects the girls were able to collectively (not just individually) work on (not just tap or "hook") identity projects with a common base. Their common identity projects supplied the rich linguistic and sociocultural repertoires (Gutiérrez, Baquedano-López, Alvarez, & Chiu, 1999) needed to organize new science ideas.

Engagement in Communities as Newcomers and Founders

The girls in this study were both newcomers to and founders of LS. In this role, they were able to craft their participation and demonstrate ways in which they could fold science into their developing lifelong stories of being urban, ethnic minority girls. Within a community of practice framework (Wenger, 1998), or even a figured world framework (Holland et al., 1998), work on "larger" narratives that are "in progress" and that span generations may be overlooked. Bourdieu (1990) argued that sometimes researchers are subject to an "occasionalist fallacy" and ignore the ways in which "an encounter is predefined by broader racial, gender, and class relations" (Duranti, 1997, cited in Lee, 2001, p. 135). Considering that narratives are constantly in progress and not bound by the lifetimes of individuals but rather are part of ongoing conversations "begun in the primeval forests and made more articulate in the course of centuries" (Oakeshott, 1962, cited in Rogoff, 1998, p. 679), it is possible that LS was merely another context for identity work to unfold. In this study, the girls' identity work, and thus their learning, is best understood as *broader than one generation* and as *broader than the development of a singular identity within one community.*

Science classrooms are typically designed for newcomers, not founders. Thus, the newcomers have very little say in what constitutes central participation (Lave & Wenger, 1991). Coupled with a limited lens of what counts as science participation, science classrooms aim to recreate a narrow set of identities. If one were to apply this narrow vision to this study, one would only *partially* account for the learning of two participants, Eloisa and Alisa. The two girls, despite many odds, unequivocally labeled themselves as scientists and used resources related to their scientist identities to productively engage in epistemic discourse (Pattern 4). Although these conversations supported the girls in critiquing scientific studies, they were rare and, it is unclear whether this form of discourse became an added tool in their "scientist" toolkits. Perhaps this was because the girls did not have enough critical episodes of PHDE, or perhaps the threads of their scientist identities were too specialized for the girls to identify with this practice. More likely than not, learning in LS was the result not of building on a scientist identity but rather of leveraging multiple identities.

CONCLUSIONS AND IMPLICATIONS

Implications for Practice

Although previous work in identity supports the idea that learners need to see themselves in the work of science and to "embed a sense of self in the discursive practices in science classrooms" (B. A. Brown, 2006, p. 121), there is little documentation on how instructors in out-of-school environments such as science clubs

can support this, particularly for marginalized youth. This study found that when science was open to critique rather than privileged over learners' experiences, participants collectively worked on broad narratives of being girls, ethnic minorities, and in some cases scientists. More than having opportunities to talk science, to see a topic as relevant, or to be positioned as "knowledge producers," the girls in this study needed opportunities to leverage common historical narratives and to work on one another's stories to productively engage in disciplinary discourse.

In revisiting the design principles for this study, it seems imperative that PDE principles be problematized through the lens of identity work and underrepresentation. In this section I examine two of the PDE principles using findings from this study. First, the idea of problematizing content (Engle & Conant, 2002) must be construed as *mobilizing the patterns problem-solving youth are already engaged in* and *not tokenizing real-world problems underserved youth face.* Problematizing content requires more than adapting the curriculum to approximate students' interests; it requires knowing how a particular group of learners frames and solves problems—understanding why, for example, individuals glean content for others. For the girls in this study "gleaning content" was not a matter of interest, it was a matter of addressing problems that beset themselves and their families. The gravity of these situations cannot be underestimated for underserved learners. Many of the girls wanted to address consequential problems stemming from inequities in health care, housing, and nutrition. Working on authentic problems in which learners feel compelled to appropriate information not only is motivating but provides a recognizable activity in which underserved learners have begun to develop expertise—in particular, helping and teaching others.

Second, the idea of providing resources must include more than accessing material resources for engaging in science talk but also *accessing the material, social, and ideational resources for identity work more broadly.* These resources must be conceptualized not as "what individuals bring to" learning environments but as "what individuals and groups have available" in structured learning environments (Nasir, 2012). This framing better suits the idea that there are collective dimensions of identity that can only be developed in the interaction of groups (in this case, groups of ethnic minority girls underserved by school).

Practically speaking, the idea of "resources available for identity work" has implications for what curriculum is chosen and which ideas are monitored over time. For starters, as educators design and vet curriculum they need to ask the following: Which identities are encouraged through curriculum and instruction? How can I cultivate the development of participants' identities, not just subject-specific identities? It also means attending to the nuances of how these identities unfold or fail to unfold in interactions. Monitoring the development of common historical identities about "helping and teaching others," "supporting the group," and "designing and creating experiments of value" in relation to science content is important. In this study, these identities supported a sense of agency that persisted

despite the girls' struggles with academic performance in school science and that were easy for the girls to use as a basis for learning to critique scientific studies. This was also the case for race-related narratives; however, further work is needed to describe how science learning environments can extend multiple dimensions of these narratives with science learning as a valued byproduct.

Implications for Research

This study suggests a few shifts in the way engagement and identity research is conducted, particularly for underserved youth. Methodologically understanding how multiple narratives interact requires having access to learners' narratives and how they view themselves in the larger context of their lives, not just in a classroom. These history-in-person narratives (Holland & Lave, 2001, p. 5) can inform discursive patterns and identities performed in classrooms. What is more, using a narrative *and* discursive approach affords opportunities to understand social and historical as well as collective and individual dimensions of engagement, identity, and learning. If this study had only taken a discourse approach, it would not have found that even the girls who did not talk much still learned science content they could relate to future images of having conversations with others. In terms of investigating identities, researchers need to avoid oversimplifying identities as either designated or discursive and continue to build theoretical ideas that explain how they can together catalyze sophisticated forms of disciplinary learning. This will also require further research on how individuals' multiple identities *intersect with one another* to support productive learning experiences.

Finally, the importance of understanding engagement for underserved youth cannot be overemphasized. More nondeficit approaches are needed; currently few identity studies target underserved students or attempt to understand these students' identities in the context of their multiple worlds of school, home, and culture (Costa, 1995). Instead of depicting students in terms of grades and test scores, this study focused on understanding how the girls' enactment and negotiation of their identities and the dimensions of their learning environments made this identity work possible. By failing to see ways in which underserved students engage, experts fail to help students create meaningful learning experiences. Or worse, they fail to keep marginalized youth from dropping out of school and deprive them of opportunities to explore who they are and who they can become, both inside and outside of science.

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APPENDIX

TABLE A1
Engagement/Identity Map for Alisa

Narratives About Previous Engagement (Interview Data)			*Narratives About Current Participation (Interview and Observation Data)*		
Extracurricular Context	*Favorite Class Context*	*Science Class Context*	*Science Class Context*	*Lunchtime Science I Context*	*Lunchtime Science II Context*
Reading and teaching cousin and brother how to read. She teaches younger family members and older sister how to read; she describes reading books by African American authors that relate to herself as an urban teen and a daughter	*Presenting a project on Michael Jordan.* "It helped other people know stuff about him" and showed "[African Americans] can do something"; "I wanted to graduate. And I wanted to prove that I could do it"; she describes	*Teaching sister how to do Punnett squares and teaching brother about hazardous waste.* She emphasizes teaching as a way to share what she learned and emphasizes the grade when talking about the importance of the project.	*Quiet participation and doing experiments.* She describes participating in science to get a good grade and describes asking questions about completing assignment. She describes a history of being interested in "any" science experiment.	*Active participation in sharing facts; PDE in designing and critiquing studies and in hypothesizing.* She describes being "helpful" by sharing information about prenatal health care with classmates, and in classroom discourse she also helps others evaluate studies. She describes learning to help herself and friends; "We can talk to pregnant teens." Two years later she describes having learned something she	*Active participation in sharing facts; PDE in learning and teaching about asthma.* She describes being "helpful." Lunchtime Science II didn't have enough experiments. She describes wanting to share information with her family members with asthma and others in her community.

	in a single-parent family.	classmates who also typically struggled but who worked hard on this project.		Two years later she describes only doing well in a class in which the teacher helped her learn.	could "pass on to others." She taught a friend about making healthy decisions during pregnancy.	
Identity work across multiple worlds						
Wants to teach and help family (family member, becoming a mom).	•		•		•	►
Wants to teach and help friends (friend).					•►	•►
Wants to learn and teach about African American culture (African American).	•	•				
Reflects on urban teen culture (teen).	•				►	
Values perspective taking and sharing.					•	•

(*Continued*)

TABLE A1
(*Continued*)

	Narratives About Previous Engagement (Interview Data)			*Narratives About Current Participation (Interview and Observation Data)*		
	Extracurricular Context	*Favorite Class Context*	*Science Class Context*	*Science Class Context*	*Lunchtime Science I Context*	*Lunchtime Science II Context*
Identity work in school and science						
Wants to become a good reader.	•					
Wants to pass classes and graduate.	•	•	•	•		
Values doing experiments in science.				•	•	Ø
Untapped narrative resources						
Becoming a child psychologist						

Note. PDE = productive disciplinary engagement.
• An important theme or thread in her narrative about being engaged.
Ø Context worked against this identity activity.
▶ Important for possible identities/future conversations.