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We Be Burnin'! Agency, Identity, and Science Learning

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This article investigates the development of agency in science among low-income urban youth aged 10 to 14 as they participated in a voluntary year-round program on green energy technologies conducted at a local community club in a midwestern city. Focusing on how youth engaged a summer unit on understanding and modeling the relationship between energy use and the health of the urban environment, we use ethnographic data to discuss how the youth asserted themselves as community science experts in ways that took up and broke down the contradictory roles of being a producer and a critic of science/education. Our findings suggest that youth actively appropriate project activities and tools in order to challenge the types of roles and student voice traditionally available to students in the classroom.

In the summer of 2007, Ron, X'Ander, and Kaden, along with 17 other youth, spent 5 weeks investigating whether their city, River City, exhibited the urban heat island (UHI) effect. One particularly hot afternoon, with laser measuring tapes, digital thermometers, notebooks, digital cameras, and video cameras in hand, they spent hours generating data that would help them to discern whether and how the downtown neighborhood exhibited the UHI effect. At the end of the afternoon, Kaden held the video camera up to Ron to capture one last scene. Ron made the following remarks, in dramatic tenor:

> This is ace reporter Ron Brown. Boys and Girls Club News. I am surprised that people don't think this is an urban heat island. Right now you can actually see the beads

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of heat-induced sweat. Do you see it? [Ron points to his forehead, where he is visibly sweating.] They are beads. Not little droplets. *Beads!* I cannot believe this! … The people around here are so *unknowledged* [drawn out]. We should really do something about this. Have a heat island awareness day. Yah. This is Ron Brown, from Boys and Girls Club News signing off. Catch you on the flip side.

This quote, featured in the boys' video documentary *We're Hot! What About You?* [6:46–7:04] captures one of the threads that permeated their 7-min video created from their data set on whether downtown River City was a UHI. The boys were alarmed that nearly everyone they interviewed was unaware of the UHI effect and its implications for River City. Yet they also espoused a confidence in their knowledge of UHIs and in their abilities to act on that knowledge to make a difference. Their situating themselves as individuals who could create "awareness" and educate the "unknowledged" brings into focus the intersecting roles of knowledge and action critical to these boys' developing knowledge base and sense of self in science.

The purpose of our study is to discern what, if any, relationship exists between learning science and developing agency during students' participation in a year-round program focused on green energy technologies. In particular, our research questions were as follows:

- How do students express agency with and in science in an informal community-based learning setting?
- What is the relationship, if any, between learning science and agency in science?

To make sense of these questions we trace the participation of a group of 20 students in the Summer 2007 component of the Green Energy Technologies in the City, or GET City, program. We draw upon video data, field notes, student-produced artifacts, and interviews to make our claims, but we rely most heavily upon a set of three video documentaries that reflect the culmination of student work in the summer program.

LEARNING AS AGENCY

Socioculturally oriented research in the learning sciences has examined how learning in informal settings is a cultural process (Bell, Lewenstein, Shouse, & Feder, 2009) that involves guided participation (Rogoff, 2003) or apprenticeship (Lave & Wenger, 1991). Such work calls attention to what and how individuals learn through observation and guidance of knowledgeable others, allowing them to be-

come fluent in the cultural practices of communities, whether they be families, community groups, or the workplace.

The imperative for such a slant on learning in informal settings is clear. As the authors of *At Home With Mathematics* (Stevens et al., 2006) argued, mathematical and scientific problems often grow out of consequential decision making with which individuals are confronted in everyday activity, such as in financial matters or health and family care. Attention to how families "assemble" and "coordinate" resources, for example, to engage the task at hand and how they seek to communicate or hide that from others is a fundamental part of the informal learning process (Stevens et al., 2006, p. 1089).

Underpinning studies of learning in informal settings is a desire to understand the process by which practices and their outcomes become shared by members of a community, such as a family or peer group, and how they are shaped by (and made sense of through) the historical, political, social, cultural, and physical realities that frame that community. It makes sense then that the vast majority of such studies on learning in informal settings have tended to group along at least three important and related trajectories: the nature of the practice and/or the task, such as its situational urgency (Stevens et al., 2006) or applied nature (Bell, Bricker, Lee, Reeve, & Zimmerman,. 2006); the broader network of resources available to engage the practice or task, such as access to experts, tools, and positions (Nasir, Warren, Rosebery & Lee, 2009); and the structures that foster and legitimize practice-based identities and positionings (Nasir & Hand, 2008; Rahm, 2008).

Whether one focuses on the task, the resources, or the networks of individuals involved in informal learning settings, there is broad agreement that learning by guided participation or apprenticeship does not happen individually or instantaneously but in "social networks that collectively perform necessary tasks and cognitive work" (Nasir & Hand, 2008, p. 144). Learning is an embodied activity that involves the ongoing re-creation of practices, roles, and identities among individuals and over time.

Furthermore, not often explicitly discussed is the focus on the "horizontal dimensions" of learning taken up in many of the studies on learning in informal environments. Gutierrez (2008) explained that the vertical dimensions of learning, which focus on movement from "immaturity and incompetence to maturity and competence" (p. 149), horizontal notions of learning focus on expertise that develops within and across practices and communities. In horizontal learning, the focus is on both the distributive nature of learning and the repertoires of practices that individuals cultivate as they move through space and time. Gutierrez's point is particularly important because little attention outside of equity-driven research has focused on how learning is informed and transformed by the sociopolitical dimensions that shape everyday activity and living, or, in Gutierrez's words, "how poverty, discrimination, exploitation, anti-immigrant sentiment, language ideologies,

and educational and social policies gone awry complicate current understandings in the learning sciences about learning and development" (p. 149).

Our work takes place in an urban setting, and we work most closely with youth from low-income families who are also of ethnic and racial minority backgrounds. As critically minded researchers, we believe that learning within and across communities must always, as Gutierrez intimated, call to question the sociopolitical dimensions of participation within community. How and why communities enact and sustain various networks of power is important for understanding learning because it shapes how communities develop a history of privileging particular discourses, identities, and forms of participation over others (see also Lee, 2003; Moje et al., 2001). Although such privileging may often be the result of the nature of the practice (e.g., science communities valuing science discourse over other discourses), it is often just as much the result of gender, race, class, and other cultural–historical structures that shape how and why people relate to one another (Bell et al., 2009). How such histories are disrupted is something we are keenly interested in as we seek to advance our understanding of learning in informal settings.

We also find ourselves calling into question what it means to think about learning as guided participation or apprenticeship, for this does not fully capture the power dynamics imbued in engaging with science (or other domains) with and among youth. Stevens et al. (2006) pointed out in fairly *a*political terms how guided participation in informal mathematical learning in the home does not account for those situations in which children appear to learn from parental mistakes rather than expertise or, as they put it, use "their parents' practices reflexively as a resource for espousing alternative practices" (p. 1090). The authors also noted how parents often "occlude" financial practices from their children or make up new ones as a result of the opportunities presented by the research (p. 1090).

From an equity-minded perspective, it is also important to recount that many youth from low-income communities do not have direct access to traditional networks of resources, such as experts in the field or materials, and when they do have access they are often positioned as recipients of the expertise rather than participants in the use and further construction of expertise (e.g., Oakes, 1990, 2000). Further access to such traditionally meaningful networks may carry little social cache among students' peer groups, which often determine social status and students' immediate quality of life (Calabrese Barton, 2003; Elmesky, 2003). In our own work, we have noted how youth routinely craft hybrid practices that rely upon traditional and nontraditional resources and that re-inscribe new meaning into the cultural and scientific symbols that frame their participation and position across a range of communities (Calabrese Barton & Tan, 2009; Calabrese Barton, Tan, & Rivet, 2008). In this sense, learning is less about practicing the routines of knowledgeable others than it is about recreating those practices in socially and culturally

situated ways that confer on one more (or less) agency with which to participate across communities.

Thus, despite sound evidence that learning science (or any other discipline) is as much about becoming a legitimate participant in a community of practice as it is about learning the content of the discipline, research in the learning sciences has been slow to deeply embrace these kinds of equity- and diversity-driven concerns (Nasir & Hand, 2006). Consequently, few conceptual models exist that help make sense of what meaningful learning looks like for a wide range of students.

Situating Agency

One way to think about the critically oriented and socially situated stance of learning we have just described is through the construct of agency. Fairly common in its application, some have cautioned against a more generic assessment of agency as "free will," for such a stance neglects the social nature of agency and the "pervasive influence of culture on human intentions, beliefs, and action" (Ahearn, 2001, p. 114). Generally speaking, those in informal and science learning have heeded such cautions and have turned in the other direction, drawing upon Bourdieu's (1977) structure–agency dialectic, which, embedded in a practice theory framework, emphasizes the recursive loop involving actions and social structures. Such a stance holds that one's actions within a given field are enabled or constrained by the social structures available there, which themselves are then recreated (or reinforced) by the actions one has taken. For example, in a study of an eighth-grade science community, Olitsky (2006) showed how the discourse of school science offers limited subject positions for youth to take up, thereby removing from view the varied options that students can create for themselves with/in science. Yet students can and do creatively take up resources within these highly constrained settings to expose tensions that may exist between dominant expectations and their own efforts to re/create themselves in science (Elmesky, 2005).

A Turn Toward Cultural Anthropology

The structure–agency dialectic resituates agency from the personal to the social realm, calling attention to how agency cannot be ascribed to any given individual but rather is field dependent (Sewell, 1992). Although we concur with the socially mediated nature of agency, we also take a more critical approach to understanding agency to call attention to both the socially *transformative* nature of agency and the intersecting roles of context, position, knowledge, and identity with agency. Ahearn (2001) argued that the structure–agency dialectic "leaves little room for resistance or social change" (p. 118). We amplify Ahearn's concerns with our own struggle with what the agency–structure dialectic does *not* actively account for, which is the way in which position, prestige, and power play out locally in how in-

dividuals seek to access and activate resources and in the meanings they ascribe symbolically and otherwise. These power dynamics are certainly field dependent, but they are also deeply entrenched culturally and historically, and socially in time and place. This is why we turn to cultural anthropology's orientation to practice theory to help us better understand these dynamics in the construction of agency.

Figured worlds.   With her work on figured worlds, Holland, a cultural anthropologist, offers a framework for moving beyond the abstract divisions of labor to consider how agency is locally instanced. *Figured worlds* are stable and shared "realm[s] of interpretation in which a particular set of characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (Holland, Skinner, William, & Cain, 2001, p. 52). As historical phenomena, figured worlds act as "traditions," offering form and meaning to people's lives. But as socially organized and reproduced phenomena, they are also "webs of meaning" in which activities, discourses, performances, and artifacts are coproduced over time and in which people's senses of self are often "divided" and "distributed" across many different fields of activity (p. 51).

The value of figured worlds in understanding agency emerges in how they set up identity and positionality as situationally contingent and under constant transformation. As Urrieta (2007) described,

> Through participation in figured worlds people can reconceptualize who they are, or shift who they understand themselves to be, as individuals or members of collectives. Through this figuring, individuals also come to understand their ability to craft their future participation, or agency, in and across figured worlds. (p. 120)

These "as if" worlds are created and sustained by how people figure themselves within them. These worlds offer new and different possibilities for how people work to figure themselves (i.e., by trying out new identities that can help transform contexts) and be figured (i.e., how contexts themselves transform identities). Agency is at once the possibility of imagining and asserting a new self in a figured world at the same time as it is about using one's identity to imagine a new and different world. This stance differs from the structure–agency dialectic, which asserts a persistence of deeply embedded relations of inequalities (Ahearn, 2001). What makes this a more compelling alternative to the structure–agency dialectic presented in sociological terms is in terms of how figured worlds call attention to the *real* and *imagined* nature of these worlds, directly implicating the locally instanced nature of identity work in the construction of agency (see Figure 1).

Holland and colleagues (2001) offered the example of participation in Alcoholics Anonymous (AA) to make her case for the dialectical relationship between agency, identity, and figured worlds. She stated,
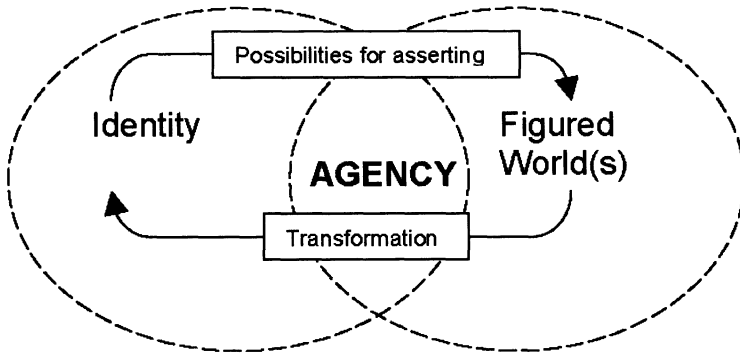
FIGURE 1   The relationship between student agency, identity, and figured worlds.

> In AA meetings participants tell stories about their lives before they joined the orga-
> nization.... They come to name themselves, and often to see themselves, as "alcohol-
> ics" and not just drinkers. All these elements of AA are meaningful in, relevant to,
> and valued (or not) in relation to a frame of meaning, a virtual world, a world that has
> been figured. (p. 51)

It is this very juxtaposition of what is real and what is imagined that offers a tool
for understanding how agency takes place in the moment and is facilitated and
constrained by power and position.

Identity. On initial entry into a figured world, novices gain social positions
that are accorded by the established members of that world. Such "positional iden-
tities" (Holland et al., 2001, p. 125) are inextricably entangled with power, status,
and rank. In addition, there is a set of appropriate dispositions tagged alongside po-
sitional identities. How novices choose to accept, engage, resist, or ignore such
cues shapes their developing identity-in-practice and determines the boundaries of
their authoring space, which is driven by a sense of agency. In the struggle to estab-
lish an identity in a new figured world, it is important to consider the influence of
the other worlds one simultaneously inhabits.

A growing number of researchers in the learning sciences believe that in order to
shed light on how students actually engage in learning it is imperative to look at op-
portunities to author and enact identities to understand the interactions and potential
tensions between student and school and/or disciplinary identities (Brickhouse,
Lowery, & Schultz, 2000; Carlone, 2004) as well as between learning and engage-
ment in both informal (Nasir & Hand, 2008) and formal (B. Brown, Reveles, &
Kelly, 2005) ways. Take, for example, the recent work of Nasir and Hand (2008). In
this study, the authors argued for the importance of practice-related identities in

when and how youth engage in basketball and mathematics. They made the point that compared to the basketball team, classroom mathematics yields lower levels of engagement and thus less meaningful learning because youth have limited access to the domain, constrained opportunities to take up integral roles, and fewer legitimate modes of self-expression. Who one is and has the opportunity to become as made possible or not through access, role playing, and expression fundamentally shapes the process of learning. Yet opportunities to develop and draw upon practice-related identities for meaningful learning can be constrained by the very figured worlds which seeks to enact develop or enact new identities. Take, for example, Brickhouse and Potter's (2001) case studies of urban girls, which reveal how girls access rich networks of science/technology resources, including, as Nasir and Hand (2008) might say, access to the domain, role playing, and self-expression. Yet such domain-specific practice-related identities carry little authority for some girls when those enacted identities do not also reflect the values of school-mediated engagement. Successful participation in school science or technology, despite a lack of resources in the home environment, can be better facilitated when students have a science-related identity they can fall back on. One of the primary claims made in this study is that students who aspire for scientific competence while not desiring to take on aspects of the identities associated with membership in school science communities often face difficulties and even school failure. Thus, the idea that identity work involves the participation of others and the social worlds they inhabit signals how youth may grapple with the sociohistorical and cultural politics that frame participation within and across figured worlds.

The figured worlds of school subjects. This culturally situated approach to agency suggests that how individuals value activity depends in part upon the purposes and goals of that activity, the relationship of the activity to local knowledge and resources, and the relative positions of power of the agents within that setting. Take Sharma's (2008) work with students in India by way of example. In his study one sees how youth drew upon their experiences with household electrical circuits to selectively negotiate new positions in school science discourse. However, the youth also purposefully positioned themselves as conforming to the norm of passive learners when classroom activity marginalized resources from the figured worlds of home and community.

Issues of power and position matter in how youth leverage resources toward making change, as we see with Sharma's students. Indeed, we desire to struggle more to foreground the role that a critical awareness of the world and the social, cultural, and political power dynamics therein play in how youth construct themselves as agents. Yet also cutting across Sharma's thesis is the idea that knowledge of the material world matters and is selectively used by agents to assert differential positions in a science classroom. Thus, our work in science education begs us to forcefully ask the following question: What role can science play in youth agency?

In working to answer this question we turn first to scholarship in mathematics education. In working closely with middle school students and teachers, Turner has argued that an important dimension to learning mathematics is fostering "critical mathematics agency," which includes (a) learning to view the world with a critical mindset, imagining the world as a more socially just place, and taking action upon these beliefs; and (b) learning to be mathematical through the development of deep conceptual understandings in mathematics and using these understandings in personally and socially meaningful ways (Turner, 2003; Turner & Font, 2007).

Critical mathematical agency goes beyond an individual's sense of himself or herself as a person whose actions can make a difference to include actions aimed at social transformation that are informed by mathematical understandings and practices. Elsewhere we have taken a similar stance to make sense of how high school physics students develop a sense of agency in physics. Our findings underscore agency as identity development, involving both the real and critically imagined worlds (Basu, Calabrese Barton, Locke, & Clairmont, 2009). The role that physics played in youth agency development was in how students' understandings of physics allowed them to impact their lives and world in both the short term (i.e., gaining voice in science class) and the long term (opening up career trajectory possibilities). However, the world of physics, as its own "as if" world, offered the youth a sense of legitimacy in their efforts to craft an empowering identity in science.

Thus, to write about "science agency" demands that we layer onto our understandings of how identity and figured worlds dialectically interact the role of science as a range of contexts and tools for enacting agency. As a *context*, science serves as its own "as if" world, allowing students the space to take up new identities and practices for tackling questions viewed as peripheral to their interests and experiences. Yet by engaging in the knowledge, practices, and identities in the *tool* of science in embodied ways, youth can also transform the worlds they traverse, which includes the "as if" world of science. Thus, agency with and in science implies that students use the knowledge, practice, and context of science *to develop their identities, to advance their positions in the world, and/or to alter the world toward what they envision as being more just* (see Figure 2).

METHODOLOGY

We have relied on critical ethnography (Carspecken, 1996) to frame our research. *Critical ethnography* is a methodology for conducting research focused around the goals of participatory critique, transformation, empowerment, and social justice (Trueba, 1999). Critical ethnography is rooted in the belief that exposing, critiquing, and transforming inequalities associated with social structures and labeling devices (i.e., gender, race, and class) are consequential dimensions of re-
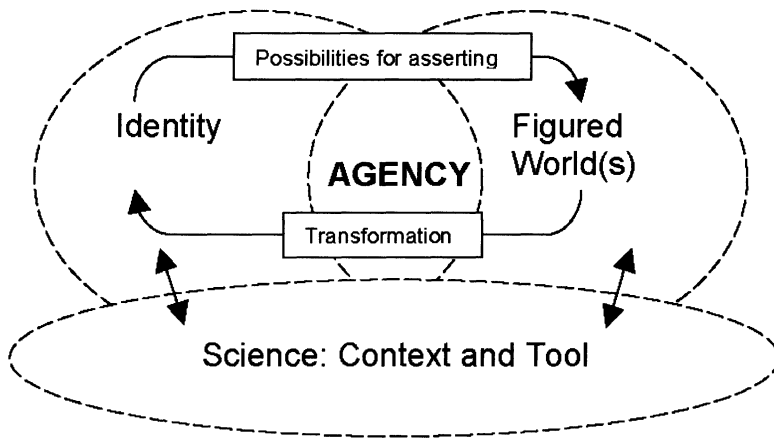
FIGURE 2   Agency with and in science.

search and analysis (Anderson, 1989). Given that urban education is marked by layers of inequalities from how schools are staffed and funded to the kinds of courses and resources available to students, the analysis and transformation of inequalities is particularly important in urban science education research. Critical ethnography also calls researchers to search for and use tools that will enable them to examine and transform inequalities from multiple perspectives, and in particular from the "perspective of the oppressed" (Trueba, 1999, p. 593). This point about perspective is consequential because the majority of youth in urban schools live in poverty at some point in their childhood, and more than half belong to an ethnic minority group. Critical ethnography also demands that the purposes, tools, and outcomes of research be co-imagined and -produced by the researcher and researched in order to break down such a binary and to allow the toils and fruits of research to be informed by a range of perspectives (Calabrese Barton, 2001).

We are teachers and researchers in this setting, and we work closely with youth who also participate in planning and research. We met daily with youth to discuss the goals of our project and to work toward new and different spaces for them to author our research with us. For example, although we went into this study wanting to understand the role of agency in learning, the youth pushed us to consider video ethnographies as the primary outcome of our work together. Although we were interested in how youth took up certain science ideas and information technology (IT) practices such as UHI explanations, digital probes, and models and graphs, the youth prompted us to consider other IT media that involved more socially oriented practices, such as YouTube and iMovie.

Therefore, in addition to gathering more traditional ethnographic forms of data, such as program documentation (e.g., attendance, lesson plans), field notes re-

corded daily and separately by both authors, and interviews with youth and club staff, we also conducted interactive conversations and worked with youth to create products that reflected their curiosities and desires. We folded these products into our database as well, offering us an opportunity to engage in content analysis of a range of student works. Following the summer experience, we followed up with a subset of eight of the youth in order to conduct more in-depth interviews.

Data analysis involved multiple stages and levels of coding (Strauss & Corbin, 1998). We developed coding schemes on those aspects of GET City that seemed to be particularly relevant to engaging youth in energy issues and in advanced IT. We paid attention to the quantity and quality of youth engagement, including by documenting which youth participate and in what ways. We also honed in on how science meanings were negotiated by youth and on how youth talked about energy issues; IT; and science, technology, engineering, and mathematics energy-related careers, noting how the language they used positioned themselves with particular roles and expertise.

Yet in seeking to build these case studies from our data set, we were confronted with the analytical challenges of how we "see" agency among the youth with whom we work, such that we might be able to document or describe it or to critically challenge our own assumptions about it. In our efforts to operationalize our stance on agency, we found ourselves faced with two key challenges. First, although we believe that agency emerges at the intersection of identity and figured world(s), both of these constructs are dynamic. We understand figured worlds through three complementary lenses, each of which captures a different aspect that cuts across time and space: (a) affordances and constraints (e.g., those resources that are tenable and valued vs. those that are not), (b) tasks and discourses (e.g., the kinds of activities and ways of being that are legitimate in the figured world), and (c) symbols and significances (e.g., whatever is emblematic of status and power in the figured world). Each lens taken alone has its own set of limitations but makes data gathering and sense making a reasonable process. The lenses when layered add complexity and keep the construct dynamic. Similarly, with identity, it is possible to describe an individual's experiences, knowledge/capital, and geopolitical and sociohistorical location, keeping in mind issues of power and position.

Our second challenge was that agency is both a generative and an iterative process/product that exists in the moment. To use this challenge to our analytic advantage, we describe agency as existing within the dialectical tension between identity and the figured world(s). Agency is not a static characteristic that can be ascribed to an individual. It emerges in context and dynamically shifts as contexts and identities shift (see Figure 3).

To make sense of how we use the stance of agency in science to ask questions about our data, take the case of "Boss," as D'Amani was known among her friends. Boss could not be missed. She was tall for her age, was boisterous, and had a strong presence. Beyond her physical maturity, Boss's discourse captured the interests
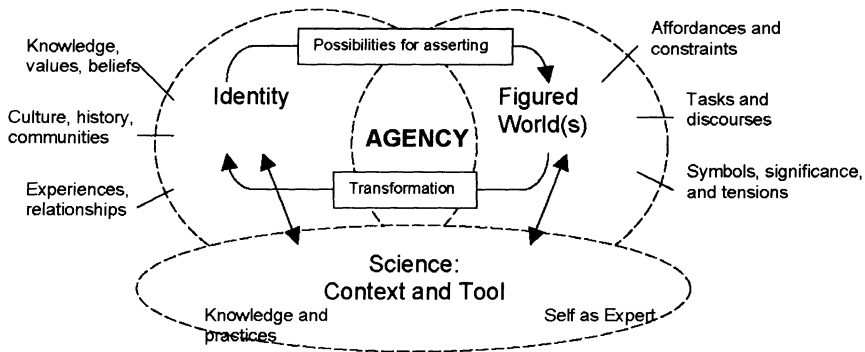
FIGURE 3   Expanded framework for agency with and in science.

and challenges one might expect of a high school student, so when we learned she was only 12, we were a little surprised. During the summer program, Boss presented us with an interesting case. Why did she faithfully come to the program each day when she made it clear that she did not have much interest in science? She did not seem to participate in any of the science activities with any real overt interest, and much of the time she spent listening to songs on YouTube.com or Jamglue.com while her groupmates appeared to be doing more of the science work. Furthermore, Boss had been clear that school carried little meaning for her, and in particular that science was boring, and she took some pride in this stance. Toward the end of the summer when the participating youth were creating PowerPoint stories about themselves and science, she announced to the group that she was not going to do the assignment the way we asked because she only wanted to write in youth speak.

At the start of the next academic year we held a recruiting session for the school-year program. One of our means of recruiting was to show part of the documentaries that the youth had created. We wanted to show part of Boss's team's documentary, *We Be Burnin'*, because it was highly effective in recruiting emotion into understanding the importance of the science they were presenting (through song, picture, and theme). Midway through the documentary, Boss, along with another team member, Michelle, act as "funky scientists" and explain the UHI effect. Boss sits contently under a shady tree on a hot day, decked in cool shades, jeans, and a T-shirt, and explains global warming in her own words.

At the recruiting meeting, we asked Boss and her teammates if they would mind if we showed parts of *We Be Burnin'*. Everyone agreed, but Boss asked, "Are you gonna show the whole thing?" We told her only about half. She responded by saying, "Are you gonna show the part where I'm talkin' [as a scientist]?" Immediately we worried that she would not want to be seen by her peers as the smart scientist, given her overt disinterest in school, and we said, "We would like to but we can

stop it right before that part." With quite an emotional response she exclaimed, "No, I want to show that part. I want people to see me as the scientist!"

This story raises questions for us about Boss's agency as she constructs an identity in science that allows her to become an expert while advancing her identity as hip-hop, cool girl. At the same time, this brief example shows how Boss skillfully engaged in the science tasks while not making it so obvious—we hardly noticed, for example, that as her group's designated photographer during the fieldwork on UHIs she took 96 pictures, all of which were intently focused on the UHI phenomena, and that she learned a wide range of IT skills. While working on their documentary, Boss was the one who chose which of the 96 pictures to include and also the one who imported the digital pictures as clips into iMovie. At the same time, Boss told us in an interview that she was not very interested in science, yet she asked to participate as one of the student experts with the second cohort of students in GET City. Our point here is that critical science agency is always situated. It is both facilitated and constrained by the resources and relationships available within any given figured world, but it can work to transform these worlds to provide richer and deeper opportunities for individuals.

THE FIGURED WORLDS OF GET CITY

GET City is a "voluntary" after-school science/technology/social club for youth aged 10 to 14. The program began in Summer 2007 with 20 students and currently enrolls 40 youth. GET City is funded by the National Science Foundation and holds as it dual goals to foster deep and meaningful learning among urban youth in the areas of advanced information technologies (including data acquisition, management, and analysis tools and communication tools) and the science and engineering of green energy. As a weekly after-school program at the Boys and Girls Club, it is also a social space for youth to congregate and talk about friends, music, school, and other social experiences that matter to them. The club largely serves youth from minority and low-income backgrounds. Because GET City also revolves around the use of an advanced wireless laptop cart, the youth who participate use their access to the computers to gain status among club youth as well as to foster the social nature of the program by using the program space to afford access to e-mail, YouTube, Jamglue, and other youth-oriented e-spaces.[1]

We put the term "voluntary" in quotes rather purposefully. Although we openly recruited youth between the ages of 10 to 14 to participate voluntarily, adult staff at the club, including the president, informed other youth that they "had to participate." For example, a sixth-grade boy who was doing very poorly in school and

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[1]Peer networking sites such as MySpace are firewalled.

facing difficult circumstances at home was told by the club president to join GET City in the hope of giving him a positive experience in an academic and social environment. In terms of the number of students, we were also limited by the number of laptops available. We wanted every student to be able to work on his or her personal laptop. We ended up with a diverse group of GET City youth with differing levels of academic success in school and interest in science and GET City.

GET City is housed in the "Club room," a multipurpose room serving as cafeteria, auditorium, and classroom space. With movable walls, it can be split into three smaller rooms, though GET City regularly uses two thirds of the space for meetings. The room is spartan but holds foldable tables and chairs, a whiteboard, three flags (United States, state, and club), and a piano. The room is located off the main social area where kids of all ages (5–18) hang out or line up to the canteen to buy candy or hotdogs. This social space opens up to the game room, the bathrooms, the computer room, the canteen, and the hallway that leads to the gym, the teen room, and the children's room. To state that it is always bustling with activity would be an understatement. The result is that GET City is positioned in the center of activity. Noise from the social space leaks into the room, and there is constant movement between these spaces as youth excuse themselves momentarily to get food from the canteen, use the bathroom, and leave for a few moments to see friends not in GET City. At the same time, the location also gives GET City status, with youth knocking on the door asking when they can join GET City.

Another important dimension to the location of GET City is that by virtue of its being housed at the Boys and Girls Club (BGC) and not in a school building, the program operates on the students' turf. The BGC is where they rule—socially— and arguably may be one of the most important other figured worlds of students' lives apart from school. A recent survey we conducted with the youth showed that 92% of the youth in GET City have participated in the BGC since they were in the sixth grade, with most of the youth having participated in the club since third or fourth grade. Nearly all of the students attend the club on average 4 days a week for 3 to 4 hr a day (4 p.m.–7 p.m.), although many stay until closing time (9 p.m.). The main reasons youth state for joining the club were summed up by Camden, age 13 ("[I] have been coming here since i was six years old. What I like about the club is that it keeps you from getting into trouble") and Le'Don, age 14 ("I have been coming here for 3 years and I enjoy being around kids where I can be myself").

Youth who do not necessarily have a lot of power or position in school do have that at the club, and they can use that position to barter for how they participate in GET City, something that they may not be able to do in their classroom. For example, a group of girls made a case for why they should be able to write their power points in "youth speak" and "hip-hop language," forms of discourse that include new words, old words with new meanings, abbreviations, combinations of numbers and letters, and symbols, often all in lowercase letters (i.e., u r gr8). For example, D'Amani's power point was peppered with statements such as "Im goin to da

7th grade and I go 2 valley magnet skool" and "Ma fave subject iz lang. artz!!! I like cuz I can be creative!!!" Yet discursive patterns are related not just to forms of talk but also to how the youth blend their talk about science and their lives in ways that frame their roles in GET City, as was evident in the titles that youth gave to their UHI videos: *We Be Burnin'* and *Where da Heat Go?*

Although GET City is a formal after-school program in which attendance is structured and there are rules for conduct and participation, it is a hybrid space that skews more toward the youths' worlds with different stakes. GET City takes place at the Boys and Girls Club, the social domain of the youth. Youth do not receive grades as they do in school. They are not ranked, and their success is not metered by high-stakes exams, as is common in their schooling experience. As teachers we work to forge a more collaborative relationship with youth than is often found in schools. Youth call us by our first names, and we actively solicit their help in negotiating and co-planning activities. Also, we have the freedom from standards and district curricular requirements such that if student interests dictate we spend more time than intended on a particular area, we have the freedom to do so without worry of penalty.

GET City also brings youth into close contact—through science—with members of the public. In their investigations into the energy crisis, students interviewed the mayor's deputy, presented their public service announcement to the local state representative, and premiered their documentaries to scientists and engineers at the local university. In the unit that followed the UHI, the youth investigated the issue around the "energy crisis" and what it would mean two generations down the road should energy consumption continue to escalate. They created 30-s and 60-s public service announcements using iMovie, and their public service announcements have been televised on the local CBS affiliate station. Some of the youth also proposed that we conduct another UHI investigation in a bigger, more built-up city 4 hr away as a comparison with what they found in River City. In this sense, doing science in GET City is framed around how and why one might want to engage in discourse with a broader range of people about why green energy technologies matter. This last point serves as both a tension and an affordance in that the youth have a chance to engage science in ways that are authentic, but at the same time they experience real pressures to accomplish meaningful tasks that can often take on a school feel (i.e., editing text, making sense of scientific ideas, figuring out how to represent data; see Figure 4).

A GLANCE AT THE CONTENT STORYLINE: IS RIVER CITY A UHI?

The UHI phenomenon was explored with the GET City youth during the 5-week unit during June and July 2007. The youth met three times a week (Monday,
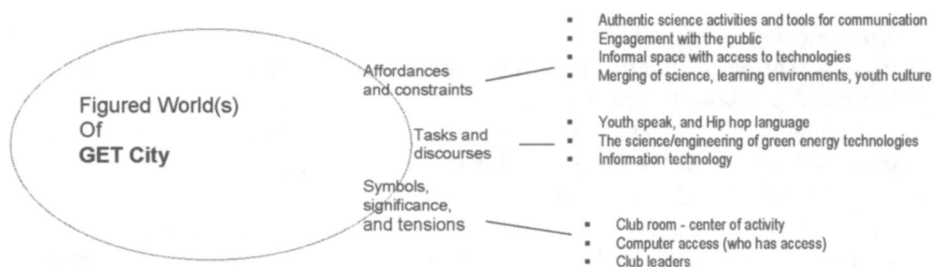
FIGURE 4   The figured world of GET City (Green Energy Technologies in the City).

Wednesday, and Friday) for 2.5 hr a day (1 p.m.–3:30 p.m.). We first asked students to consider whether River City is a UHI and how we might find out. Because none of the students had ever heard of this concept before (as we had anticipated), we asked them to consider the following: Where would you rather be on a hot summer day? Standing in the middle of a mall parking lot or under a shady tree? An animated debate followed, raising a set of relevant issues: A mall parking lot would be hot and uncomfortable but a desired location because it would mean you were heading to an air-conditioned mall to shop. A shady tree would be cooler and relaxing but possibly boring, with no proximity to air conditioning, shopping, or cold drinks. Immediately, the youth pushed beyond the intended science question of which decontextualized space would be cooler and thus more comfortable to the more complex consideration of how these spaces are situated physically and socially with everyday desires and practices.

In the next three sessions the youth investigated the idea of UHI through a series of controlled experiments that uncovered the relationship between surfaces, temperature, and building design. Our purpose was to engage the youth in using the scientific process to learn that when various surfaces are exposed to similar environmental conditions, surface temperatures may vary because of differences in thermal properties among the surface types. We also wanted them to consider how the use of light-colored roofs and ground surfaces may help reduce UHI effects. The youth were then charged with building model homes out of dark- and light-colored poster board and systemically and repeatedly recording indoor and outdoor air temperatures in a variety of youth-determined locations around the club property using digital thermometers. They then constructed bar graphs representing their average results and built theories about the relationship between surface type and temperature. For example, Jeremy, whose graph is depicted in Figure 5, offered this explanation:

In this experiment a black house in the shade outside was 77 degrees Fahrenheit but in the sun it was 105.4 Fahrenheit. The outdoor temperature was 77.6 Fahrenheit in the shade and 98.9 Fahrenheit in the sun. This is important because if we had lighter
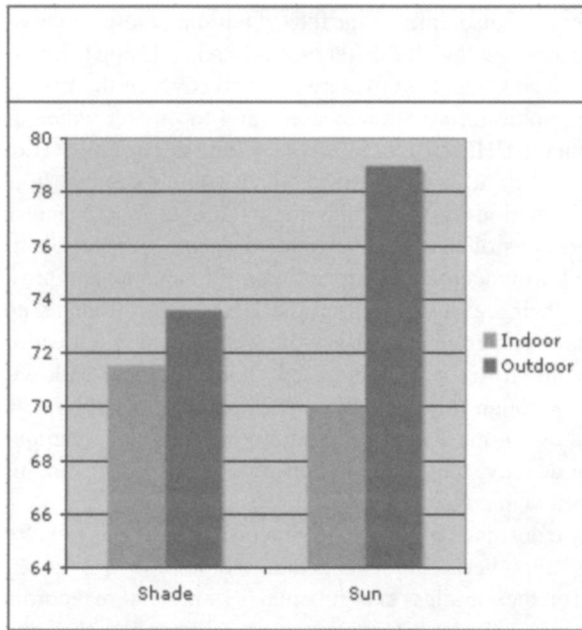
FIGURE 5 Graph produced by Jeremy, a member of the group the Heat.

colored houses it would not be as hot. If we had a rooftop garden it may not be as hot and it would help absorb carbon dioxide.

Next we engaged the youth in exploring the relationship between land cover and surface temperature. Our original lesson design was to have the students build model landscapes, such as a simulated city with a high percentage of land space covered with buildings and streets or a simulated park with high percentages of green space, and then repeat the experiments conducted with their homes. Our intended goals with this lesson were to help the youth distinguish the three main types of environments—urban, suburban, and rural—by learning characteristic land cover types and then to investigate the effects of different land covers on local air temperatures. We wanted this to build to the youth predicting surface and air temperatures from aerial photos showing various land cover types found in River City.

However, when we initiated the conversation around land cover the youth were, on the one hand, intensely interested in and somewhat knowledgeable about the differences in land cover and surface temperature—indeed their talk about the heat in parking lots, playgrounds, and asphalt basketball courts framed our talk. On the

other hand, they were disdainful of the idea of building more models. They became quite keen on really "seeing" the difference for "real." Using their suggestions, we replanned and asked students to explore the land cover of the River City community using geographic information systems and to predict which areas of River City may exhibit the UHI effect because of the built environment (field notes, June 2007). This approach allowed us to introduce youth to spatial thinking through geographic information system technology (Google Earth) and allowed them voice in how we constructed our investigation. Youth were to select a geographic area in Google Earth, document its location, print the map, and provide an explanation for why their site might exhibit the UHI effect. Students presented their ideas in pairs and as a group. By class vote we selected two locations to conduct our work: downtown River City and Eagle Island, a local park with a lake and wooded trails. Through their selection of these two locations that would most likely present a big contrast in temperature measurements, geographical features, and population density, the youth demonstrated their understanding of the relationship between land cover and the UHI effect.

As a class, we designed a set of data generation strategies to help prove or disprove students' hypothesis. Students generated the following ideas that were directly modeled on their in-class experiments: (a) temperature recording in multiple sites, in both sun and shade; (b) measurements to determine the square footage of built areas versus green areas; and (c) documentation of the nature of the built and green spaces (i.e., kinds of buildings, colors of roofs, vegetation). However, a small number of students lobbied to "talk to" people who worked or lived in these buildings to determine if they could "feel the heat" radiated by the human built structures. Thus, we also added to the design (d) interviews with residents and workers in these spaces of their "heat island" experiences and (e) photographs of critical design factors in the environments.

Because of time constraints we visited just one of these sites, which was downtown River City. During our visit to downtown River City students split into three groups. Each group was assigned an adult leader, a student group leader, a recorder/interviewer, a measurement keeper (temperature and space, using digital thermometer and laser measuring tape), a camera crew, and a photographer. We took the club van to downtown River City, parked in a lot down the street from the state capitol building, and agreed to regroup in 2 hr. The students had prepared for the investigation by listing questions they wanted to ask community members. Some of these questions included "Do you like it at downtown River City in the summer?" "Do you know what an urban heat island is?" "Where in River City do you think will be an urban heat island?" and "How do you stay cool in the summer?" (field notes, student handouts, 2007). Although we encouraged the students to think about how they might "talk science" with the residents and workers they interviewed, the students themselves were concerned with how residents and workers might personally experience the UHI phenomenon. They were concerned

with making talk about UHI accessible to their interviewees in whatever ways seemed most relevant.

During the 2 hr the youth conducted their experiments, interviewed individuals, and took pictures. None of the groups followed the same route or pattern. Some interviewed individuals who worked in the state legislature, whereas others interviewed workers in the state capitol building and police officers.

Our original plan was to have students write up their results in a format that could be presented to the mayor's office. However, the students became very excited about their video footage, and they expressed an interest in being able to do something with their video. We had had success in the past working with youth in creating video documentaries, so we offered that as an option to the students with the requirements that the documentaries (a) present their data findings, (b) educate others about the UHI effect, and (c) be 10 min or less.

Using an iterative process of storyboarding, video editing, and concept mapping, the youth produced three video documentaries: (a) *Where da Heat Go?* (b) *We Be Burnin'*, and (c) *We're Hot! What About You?* (http://barton.wiki.educ.msu.edu/Exemplars; see Table 1). The mini-documentaries featured the students investigating the UHI phenomenon in the downtown area of their city using temperature sensors, laser tape measuring devices, observations, and interviews conducted with members of the community. The documentaries were the final, culminating product from the students' investigation and were representative of the issues and concerns about UHI that had spanned the youths' investigation. They incorporated the data students generated during the 5-week unit (i.e., images, figures, and graphs produced from experiments conducted) as well as youth culture (e.g., music selections, discourse; see Figure 6).

CRITICAL SCIENCE AGENCY: BECOMING COMMUNITY SCIENCE EXPERTS (CSEs)

We stated earlier that agency with and in science involves a critical awareness of the role science plays in the world and of the world itself, alongside understandings of scientific ideas and ways of thinking that can be used toward making a difference in the world. Yet we also stated that how these actions are taken and the meanings they carry are situated in the contexts that generate them. As we sought to operationalize agency as the dialectic relationship between the expression of identity and the figured worlds in which one moves, we began to see the importance of how youth re-presented themselves in GET City, and in particular within the context of the video documentaries, one of the most public displays of their efforts. It is from this perspective that we argue that the youth asserted themselves as becoming CSEs. We use the phrase *community science expert* to impart the idea that the youth actively positioned themselves as individuals who were knowledge-

TABLE 1
Summary of Mini-Documentary Content

	Da Heat (8:41)	Burnin' (8:44)	We're Hot! (7:44)
Community Dialogs	Female tour guide (0:38-1:00) Man visiting capital (1:10-1:44) Man walking to work (1:51-2:04) Woman and friend walking downtown (6:15-6:45) Two women walking downtown (6:15-6:45)	Male capitol building worker (1:54-3:02) Two guys standing under a tree during lunch hour (3:34-4:43)	Female parking enforcer (1:51-2:20) Female tour guide (2:22-2:38) Male police officer (2:50-3:35) Family visiting from TX (4:12-4:27) Female House staffer (4:27-5:18) Probing about vehicle use and heat emission (2:10-2:20) Impact on police officers jobs (2:50-3:35) Offers definition of UHI (4:34-4:41)
Supporting comments and ideas to directly educate community members	Cierra pointing to trees (1:20) Cierra referring to downtown Lansing (2:00)	Explanations of UHI effect as it relates to particular peoples' occupation (3:11-3:31)	
Types and kinds of misconceptions noted in community member knowledge	Islands (bodies of land surrounded by water) are UHIs (2:11) UHIs cannot exist where it rains (3:14) UHIs cannot exist where there are lakes (1:00) A highly populated area in a city does not contribute to the UHI effect (1:10) General lack of knowledge (1:51)	General lack of knowledge (1:54-3:02; 3:34-4:43)	UHI effect must be present 100% of the time to be a serious consideration UHIs cannot exist where it rains (2:22) UHIs cannot exist where there are lakes (2:26) A highly populated area in a city does not contribute to the UHI effect General lack of knowledge (3:40)

Foci of specific UHI claims	UHI definition (3:37-3:42; 3;44-3:49)	UHI definition (2:10-2:17; 4:04-4:12; 5:02-5:20)Global warming explanation (5:54-6:04)	UHI definition (4:34-4:41; 5:38-5:59)
	Human consequences (3:54-4:00)	Human consequences (5:21-5:47)	Human consequences (5:59-6:07)
	Environmental consequences (4:00-4:09)	Environmental consequences (6:0506:22)	Causes of UHIs (6:08=6:29)
	Cities where UHI effect is known (4:15-4:35)	Recommendations for UHI effect reduction (7:10-7:32)	Explanation of investigation (1:3701:49)
	Recommendations for UHI effect reduction (4:49-5:32)		How to mitigate the UHI (6:29-6:35)
Forms of evidence used to support claims (including types and quantities of representations)	Temperatures in downtown locations taken in sun and shade, in various stages of "built" spaces. (2:57-3:06; 6:58-7:35)	Map of River City (0:05-0:09)	Temperature recordings (0:33-0:52)
	Explanation of experiments conducted with graphical representations of findings (3:06-3:18; 3:18-3:27)	Explanations of research roles—temperature taker, photographer, ect. (0:27-0:57)	Observations (0:59-1:24)
	Graphical representations of temperature stratification (3:22-3:27)	Temperature readings in various locations (1:13-1:29)	Images of the sun (0:52)
	Figure demonstrating UHI effect (3:42-3:44)	Images of UHI effects	Cartoon images of a hot and polluted earth (6:36)
	Infrared images of five major cities (3:44-3:49)	Cartoon images of a hot earth (5:48-5:53)	Images of selves collecting data (digital thermometers, charts, ect.) (0:32-0:52)
	Images of the built environment (4:15-4:35)	"Expert" scientist opinions on UHIs and global warming (5:02-5:47; 5:54-6:22)	Google Earth Fly into River city (highlighting built environment) (0:00-0:26)
	References to EPA findings on UHIs (3:44-3:49)		

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TABLE 1 (Continued)

	Da Heat (8:41)	*Burnin'* (8:44)	*We're Hot!* (7:44)
Localized explanations	Why you should care (3:54-4:00; 4:35-4:49) How it affects River City in particular (0:00-2:23; 3:42) What kids have to do with it (4:49-5:32)	Explanations of UHI effect as it relates to particular peoples' occupations (3:11-3:31)	How UHIs impact workers in a variety of occupations
Affective triggers	Photos of people and animals and music to evoke emotional responses (polar bears, children, polluted environment) (4:35-4:49) Behind the wacky scenes (5:32-8:41) Music • Run It (Chris Brown) • Irreplaceable (Beyonce) • Hot Hot Hot (BusterPointdexter) • Umbrella (Rhianna) • Where is the Love (Black Eye Peas) • World's Greatest (R Kelly)	Photos of people and animals and music to evoke emotional responses (polar bear with cubs, polluted environment) (1:48-1:50; 6:23-7:09) Music • Mercy Me (Marvin Gaye) • Umbrella (Rhianna) • I've Got the Power (Snap) • Stop in the Name of Love (Supremes) • Please Remember (Le Ann Rime)	Beads of sweat (3:40) Animals (2:50; 4:03) Music • The Heat is On (Glenn Frye) • Wish It Would Rain (Temptations) • Peanut Butter Jelly Time (Buckwheat Boys)

Note. UHI = Urban heat island.

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Key concepts [Lesson plans]	Activities [Lesson plans & student handouts]	Student-generated data [Student handouts & fieldnotes]	Relevant issues students raised in discussions [Fieldnotes, student artifacts]
Phase I: 18-25 June, 2007 • What are urban heat islands (UHIs)? • Where are they found? • Does the color and location of a building affect its indoor/outdoor temperatures?	• Locating mini-UHIs at the club • Color and location –Students built black and white construction paper houses and measured indoor/outdoor temperatures of the houses in the shade and in the parking lot. Graphed the results.	• Mini- UHIs at the club include the parking lot, basketball court, kitchen, and pantry area with a hot-dog machine • Black houses are hotter than white houses, both houses are cooler in the shade under trees than out in the parking lot	• Avoiding their kitchens at home in the summer • Not wearing a black or dark colored T-shirt in the summer • A parking lot is likely to be near an air-conditioned mall, which makes it a better location than under a shady tree for cooler temperatures
Phase II: 27 June-18 July, 2007 • What does aerial photographs tell us about UHI effects? • How does urban planning affect the UHI effects? • How can UHI effects be ameliorated?	• Using Google earth to study how landscape and urban planning affect UHI effects • **Student initiated an onsite investigation of the UHI phenomenon at downtown River City** • Students conducted online research on UHIs, global warming and what individuals can do to ameliorate the effects • Students used i-movie software to create mini-documentary	• Identified downtown River City as most built-up, with dark asphalt roads, and dark buildings, most likely to exhibit UHI effect • Students researched and learned about the causes of UHIs and global warming, and the effects on humans and the environment • Students researched and learned about what they and people in their community can do in their everyday lives to help with the UHI and global warming effects	• Students wanted to experience the UHI effect for themselves for a more authentic investigation • Students' desire to carry out an ethnographic investigation on how UHI affects community members- "localizing" the science • Students wanting to share and "teach" what they've learnt about UHI to others, using youth-centered media (a movie about science strongly infused with youth speak, hip-hop music, cartoons, etc)

Culminated in three mini-documentaries on UHI in River City, premiered at local state University on 20th July, 2007

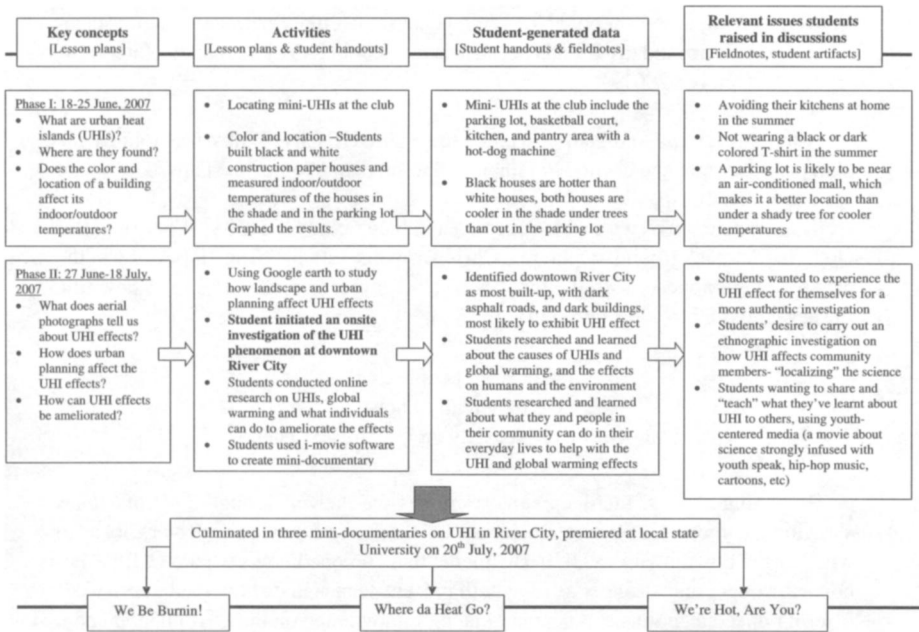| We Be Burnin!	Where da Heat Go?	We're Hot, Are You?

FIGURE 6   Data flowchart of UHI investigation process at the Boys and Girls Club.

able in science and, in particular, about the UHI phenomenon—in what it is, in how to generate and interpret evidence about the phenomenon at the local level, and in why this is important for their community to understand. To make sense of how the youth did this, we share an extended vignette, *Where da Heat Go?*

> *Where da Heat Go?* is an 8 min and 41 s scientific documentary produced by four students, Jeremy, Shernice, Naomi, and Kathy, all of whom were rising sixth graders. Two of the students (Jeremy and Naomi) had an interest in science and were set to start at the science and engineering–focused middle school in the fall, and the other two (Kathy and Shernice) spoke passionately about how science is for nerds, except in GET City, and were set to attend a middle school for the arts and a zoned non-themed middle school, respectively.

Shernice: Sometimes I like to be scientific, but sometimes I don't. I don't like to be scientific. Most of my friends are cool and you be scientific and they think you are a geek.

Kay: [interrupting] We don't think that.

Shernice: [forcefully] At my school. OK!? I kind of do like to be scientific here because it makes me look like I know it all and that is kind of fun.

Kathy: Well, at my school? No! Well, because just like Shernice I am not scientific around my friends because at my school it doesn't matter. (Interview, October 2007)

Although Jeremy and Naomi wanted to be in GET City, Kathy was told by the club president that she needed to join, and Shernice then joined to share more social space with Kathy.

Their movie opens with a black screen and blue text: "GET City: Where da Heat Go?" In the background is playing Chris Brown's (2005) "Run It!" At 18 s, the group's photo appears with the text "The Heat" layered on top. At 23 s, a new title flashes across a black background:

<div align="center">

Look at what people think …
… Do they really know?????
Is downtown River City an Urban Heat Island?

</div>

Beginning at 38 s, the documentary moves the viewer through a set of scenes showing the youth interviewing residents and workers of downtown River City as to whether the downtown is a UHI. The theme that "no one knows what a UHI is" becomes stronger and stronger as the youth present scenes that show the interviewees offering misconceptions and a general lack of knowledge on the UHI phenomenon. For example, the first interview with a tour guide for the capitol building reveals the misconception that UHIs cannot exist where it rains:

Student: Is River City an urban heat island?
Tour Guide: No. I wouldn't consider that, no.
Student: Why not?
Tour Guide: Why? Um just because we're in the city, we have more businesses down here which would mean, yes we would have more heat but, we get a lot of rain in Michigan and we're right in the middle of two huge lakes … No I don't think we are heated.

Each one these interview scenes is followed by brief musical interludes with snippets from Mim's *This Is Why I'm Hot* and Buster Poindexter's *Hot Hot Hot* and accompanying captions that state "I don't know!"

Following the interviews, the youth present some of their data gathered in the downtown area, including the temperatures recorded in the sun and shade at various "green" and "built" points around the capitol property. After another brief musical interlude (Buster Poindexter's *Hot Hot Hot*), the scene cuts to a series of pictures of the model houses the students had built earlier in the summer, and in the background Jeremy offers an explanation of the experiments and how they provide evidence for the UHI effect. A graphical representation of indoor and outdoor temperature measurement conditions in the sun and shade of a black versus white model house is shown. At the end of the scene, an image of Jeremy punching himself in the face while making a funny face is shown with the subtitle "Expert Reporter."

The third set of scenes (3:40–5:40) presents the viewer with a deeper explanation of what UHIs are and their impact on environmental and personal health.

Shernice: An urban heat island is where urban heat air and surfaces have temperatures that are up to 10 degrees F higher than the surrounding natural land covers. Downtown River City is an example of an urban heat island.

Kathy: Consequences of an urban heat island. Cities experiences higher relates of illnesses and death due to dehydration. Approximately 7,421 deaths occurred between 1979 through 1998 because of urban heat islands.

Shernice: Consequences of heat islands to the environment. Heat islands produce ozone pollution, which provides great damage to vegetation and local ecosystems.

Together: HEAT ISLANDS ARE A BIG NO NO! WHAT CAN YOU DO ABOUT IT?

Accompanying the voiceover are pictures of major urban centers in the United States where the UHI effect has been documented by the Environmental Protection Agency (i.e., Atlanta and Los Angeles) and other cities that matter to the youth (i.e., Detroit and River City). In the background, Rihanna's *Umbrella* (Terius, Stewart, & Z, 2007), a current hit hip-hop favorite, is playing. The youth selected this song because some UHIs have been documented to create their own weather patterns, causing more rain to fall on the eastern edges of these cities, a fact the youth learned by exploring data offered by the Environmental Protection Agency (http://www.epa.gov/hiri). They also use graphical representations to demonstrate the relationship between the temperatures of the UHI versus the surrounding areas.

The documentary moves to pictures of polar bear families, and the voiceover focuses on the relationship between UHIs and global warming and its impact on biodiversity. The subtitles state "Polar bears are drowning because the arctic ice is melting." The song transitions to *Where Is the Love?* (Black Eyed Peas, 2003), whose lyrics describe that "something is wrong with the world" and how we need to act to turn it around. The second to last scene offers a series of suggestions for "what can we do about it," and the song transitions to R. Kelly's (2001) *The World's Greatest*, suggesting that kids can and will make this needed difference.

This vignette reveals how the youth took seriously their commitment to developing and sharing an understanding of the UHI effect and its impact on human and environmental health and global sustainability. If we unpack the vignette, we begin to see that the youth leveraged several mechanisms to assert themselves with and in science. Although we use the video as the focal point in this analysis, it is important to remember that the video represents a culmination of several weeks of work and decision making. The students pointed out common misconceptions about UHIs with the opening interviews—that UHIs are real islands and that UHIs cannot exist where it rains. They offered scientific explanations tailored to their context, drawing upon a range of scientific evidence, including primary evidence

they had generated and data available from the Environmental Protection Agency. They juxtaposed select music lyrics with scientific discourse to hone in on what they considered to be the critical ideas and the timely imperative such ideas raise, such as they did in their penultimate scene with the Black Eyed Peas (2003) *Where Is the Love?* featuring the lyric "We've only got one world."

An analysis of our data reveals that although the youth used a variety of means to assert their knowledge in science, at least two patterns reflect powerful mechanisms by which students exerted themselves as CSEs through appropriating the ideas, discourses, and practices of science: (a) authoring an investigation and (2) taking up an expert stance. These mechanisms are powerful because they show that as CSEs the youth are knowledgeable about science and that they consistently blend what they know and can do with who they are and desire to be, tenets central to developing agency.

Authoring an Investigation

The youth authored the UHI investigation in three ways: insisting on a real-life, community-centered investigation; framing the UHI challenge by highlighting personal accounts; and positioning themselves as agents.

Insisting on a real-life, community-centered investigation.   As teachers we had initially authored a summer program on UHIs. The participating students performed the requisite activities and experiments we had designed. They reflected and blogged on questions such as "What color T-shirt would you wear on a hot day to keep cool?" They made predictions about which building material properties might have an impact on ambient indoor and outdoor air temperatures. They discussed images of the main types of environments—urban, suburban, and rural—and made conjectures about characteristics of land cover types. They built model cardboard houses out of different-colored poster board and recorded temperatures in sunny and shady locations, graphed and compared results, and built theories. After building cardboard houses, our subsequent activity was to have the students design and build small-scale model landscapes to further investigate the UHI phenomenon. However, several of the youth indicated a desire not to build more models but to investigate whether this phenomenon was actually real in their city. They wanted to do an onsite investigation of their community.

Doing an onsite investigation grew out of one boy's fascination with "thermal images." This boy's group had taken what they had thought were thermal images of their houses in the sun and shade (using the "thermal camera" effect in their iSight camera[2]). They had recalled similar thermal images of cities we had shared

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[2]iSight's thermal effect works off brightness, not heat, so this really is not accurate.

previously to engage the youth in conversation around thermal stratification in the built environment. They shared their pictures as part of their data set, setting off a conversation about whether any images of River City existed that revealed its thermal stratification, but no one could find any on the Internet.

Documenting the UHI effect in River City had been part of our summer plan, and the youth were aware that toward the end of Week 3 we would make fieldtrips to various locations in the city to collect a set of data parallel to our initial experiments. Yet the talk that initially emerged from the group of boys around their thermal image set off a cascade of requests to do the fieldtrips now! The boys were sharing their images as part of a larger discussion we had around their house models and that we were conducting to set up talk on their next investigation, the model environments, discussed earlier. We decided to listen to their pleas and engaged them in dialogue around "what would they do" to figure out whether River City exhibited the UHI effect. Although it may very well be that the real impetus for getting on to the trips was to get out of the classroom, embedded within their negotiation were indicators that the youth understood the content well enough to drive the investigation, but equally as important was that they were the ones uniquely positioned to know how and why this content mattered to them and to the residents of their city.

With the youth, we negotiated an investigation that included the following: They would use Google Earth to visualize the local environment, to document differences in the built and natural land cover, and to hypothesize locations where they thought they might find evidence for the UHI effect. For example, the group that selected "downtown" argued that from the Google Earth image, the downtown area contained "the most number of buildings that are close together" and "had lots of streets and few parks." They also discerned from the imagery that many of the downtown buildings had "dark-colored roofs" that were similar to the conditions of their experiments. As discussed earlier, after selecting a portion of downtown that contained to them the most densely built spaces, the youth produced a viable scheme for gathering useful evidence that in essence modeled our previous experiments. This included taking multiple temperature readings at various locations, measuring the square footage of the built versus natural land cover, and documenting the nature of the built and natural land cover (i.e., white concrete vs. black asphalt). We encouraged them to add another element: interviewing local residents and workers, in ethnographic fashion, to gather ethnographic evidence for human impact. The youth took up this suggestion enthusiastically and spent time writing potential interview questions and practicing on one another. Before embarking on the fieldtrip, the youth also practiced their interview skills with the adults at the club.

Framing the UHI phenomenon through personal accounts.   As discussed in the section on the content storyline, the youth lobbied to include less formal interviews (in addition to the structured ones we designed together) and photographs as part of their strategies for gathering data on the UHI phenomenon in the down-

town area. Their prepared questions included a focus on how the UHI phenomenon might frame residents' and workers' experiences. In the actual data gathering process, the youth expanded upon these questions such that when residents or workers did not know about the UHI phenomenon but could explain how or why they might feel hot in the downtown area on a sunny day, the youth would integrate a discussion of what they knew about the UHI phenomenon with such feelings in what seemed to be an effort both to personally connect with residents' and workers' stories and to engage these individuals in thinking about UHIs.

In the excerpt that follows, Ron and Kaden are talking with a parking enforcement officer (PEO) they encountered on while gathering data downtown. Although neither boy explicitly shares his knowledge of UHIs at this point in the interview, both seem to be using what they know about UHIs to direct the conversation to focus on how the UHI effect can have a significant impact on one's occupation. When Kaden asks about the cars, he pushes the PEO to reflect on how a car's air-conditioning system may contribute to the UHI effect. Given that the youth had learned about how cars, factories, and air conditioning add more heat to the dome of elevated temperatures over a city, we see this question as loaded with implication. Knowing about UHIs matters not only in being able to describe what a UHI is but also in understanding the relationship between the causes and effects of UHIs and everyday living and work life.

> PEO: It was pretty hot about three weeks ago. It was already 94 degrees with a heat index of 100. And I was working the [community college] area and it was really hot I can see it got hot.
> Ron: What do you think is the impact?
> PEO: Well, I guess it would impact as far as me walking the streets and the sidewalks radiating the heat. People leaving on vacation for the summer, to get out of the heat from their jobs, so I don't have that many areas to patrol. so I think those are two ways.
> Kaden: Do you have a car, like those little cars that you drive around?
> PEO: Yes I do.
> Kaden: And, do they absorb more heat when you have your air on or off?
> PEO: We don't have air conditioning on our scooters. They are three-wheel scooters and they don't have [air conditioning]. We could have [air conditioning] on them, but the city does not supply that. Right now we are parking them for most of the day. We only drive to our destination and back to our checkpoint.

That youth turned the added-on component of interviewing community members into the centerpiece of their argument provides further evidence of how they valued these personal accounts. In each of the documentaries, an average of 2:08 min (of an average total of 8:23 min) was used in presenting community member interviews. In each documentary, the interviews were presented primarily in the first half and used to set the case for the UHIs by presenting common misconcep-

tions, showing how UHIs affected people differently because of occupation, and showing a lack of awareness on the issue.

Take, for example, the opening scenes of *We Be Burnin'*. Similar to *Da Heat*, the movie starts off with the title "WE BE BURNIN'!!!" in yellow block text against a black background, followed by the question "What's wrong with this planet?" Marvin Gaye's (1971) song *Mercy Mercy Me* plays loudly in the background. A map of Michigan showing River City and Detroit is then shown, with the text "River City ... That's where we live!" Another question, "Why is it so hot???", pops up against a background of a photograph showing an adult staff member at the Boys and Girls Club, Anna, looking down at Kay outside the club on a very bright sunny afternoon, positioned to suggest that she is asking Kay the question. After then presenting the key characters and their roles in the documentary, the scene cuts to Michelle, the temperature taker, explaining the fact that on a day when the temperature in the sun is close to 90 degrees, it is cooler under the shade of a tree: "Ok, I am taking temperatures because outside is hotter than under the tree just 'cause it's shady, so I'm taking the temperature outside of the tree and inside the tree. And now the temperature is 79.5."

The scene quickly switches to a screenshot that reads "BURNin', BURNin', BURNin'" against a background photograph of a brilliant sun. Two more questions then are presented: "Do you wonder why we be burnin' in the summer???" followed by "What are people sayin'??" This leads to a series of interviews conducted by Kay. Kay first interviews a worker in the state capitol building. The worker appears hot and sweaty and is sitting in a chair looking a bit tired. When Kay asks the man to name a UHI and he cannot, she tells him that downtown River City is one. When he laughs with surprise, she asks him if he knows why it would get so hot in the summer in downtown River City, and the man shakes his head, looking somewhat baffled:

A1:   [shakes head] Umm, uhh... I think, scientifically I don't ...
Kay: There are trees and there are grass and it helps the heat island effect because, it makes it more shady ... and instead of everybody being hot and instead of people being, people not like, being, not to like being downtown, they can kind of enjoy it if they just go in the shade.

As we can see in the transcript, how Kay talks about her understandings of UHIs and to whom this expertise is shared differs from school science talk. Kay focuses her talk on how the design of the urban environment can help to mitigate the UHI effect, and how one can find relief from the heat. Given that the man she is interviewing is clearly tired and hot, this explanation positions her as the expert who is trying to help. Admittedly, Kay had one of the weakest understandings of UHIs of all of the students in summer program, but she was also the youngest member of the group, being the only 10-year-old in the program.

In each of these examples we see how the youth used their mini-ethnographies to give perspective to the UHI experience by situating the phenomenon personally. We also see how the youth used the interviews to offer a range of informal insights into the phenomenon. However, if one follows the dialogue the youth had with the informants, one can also see a hybrid account of the UHI phenomenon emerging—that is, an account that is scientific in that it presents the viewer with scientific terminology, reasoning, and representations but also in that it is only made possible by how it is situated by the varied personal accounts.

In another example, Ron and Kadan interview a staffer for one of the democratic state representatives. Similar to the previous example, in which Kay urges on her interviewee with ideas and information about UHIs, Ron offers information to urge on his interviewee. When Ron asks the woman if downtown River City is a UHI, she returns his question with a puzzled look on her face and repeats the phrase: "A UHI?" Ron then responds with a description that is fairly informal but descriptive, allowing the staffer to make a connection to the idea:

Ron: A [UHI is a] place generally with no trees, lots of buildings, lots of blacktop, parking lots and stuff to attract heat.

Staffer: I would think to an extent. Most of these have taller buildings than ours, like Chicago, there's a lot of little parks downtown that help with the green space.

Kadan, who is with Ron, then turns the interview to how this woman's work intersects with their concern by asking if the state government is doing any work on UHIs, and a short conversation on the Democratic cause's renewable energy packages ensues.

It is in the scene immediately following in which Ron stands in front of an American flag and offers a fairly formal explanation of UHIs. Centering the ethnographic accounts of the lived UHI experience allowed the students to coauthor the imperative for an investigation into whether downtown River City exhibits the UHI phenomenon.

Positioning themselves as agents.   In addition to the mini-ethnographic accounts, both the planning for the downtown experiment and the resultant text in the movies were presented in an active voice with an explicit agent. This is in contrast to traditional science discourse, which favors a passive and more impersonal voice. Schleppegrell (2001) demonstrated that such a discourse imbues a sense of technicality and therefore authoritativeness to scientific language. However, by explicitly situating their text and emphasizing an agent, the youth took a stance and created a sense of urgency and immediacy that demanded a response from the audience. In the last segment of the *We Be Burnin'* movie, the following text accompanies a montage of polar bear photographs together with Leann Rimes's (2000) song *Please Remember*:

Text	Song Lyrics
POLAR BEARS …	Goodbye, there's just no sadder
THEY ARE OUR FRIENDS …	word to say
Please don't kill us …	And it's sad to walk away
It's not our fault …	with just the memories
We want to grow up and live …	Who's to know what might
What can we do to help our friends	have been
the polar bears?	We'll leave behind a life and
What can you do to reduce the heat	time
island effect? Everyone can do	We'll never know
something!	again

How the youth highlighted the plight of the polar bears exerts more authority in possibly evoking a response from the audience than would a passive, impersonal presentation of the same information. However, what we think is important is the *blending* of these personal and emotion-invoking accounts that deeply situate the experience with more formal presentations of what UHIs are—presentations that include the use of real-world data, scientific representations, and scientific terminology—that position the youth as authentic CSEs.

In each of the cases presented and throughout the documentaries, what makes the representation of scientific expertise different from school is the focus on tailoring the knowledge to the perceived needs of the receiver as well as situating these understandings within the subjective and the everyday. Even in the latter part of the videos when explanations were meant to be deeply scientific, these explanations were rooted in the personal and meant to connect to the viewer at a visceral level.

As expert reporter Jeremy did in *Da Heat* (see the opening vignette), the funky scientists in *We Be Burnin'* offered explanations of the UHI effect, drawing upon scientific discourse combined with emotion-evoking images, scientific representations, and youth imagery. After the scientific speak about the health and environmental implications of UHIs, which includes statistics taken from the Environmental Protection Agency, five still photographs of polar bears are presented as the spokes-animals for global warming prevention. Subtitles added to the pictures areas follows: "Polar bears … They are our friends … Please don't kill us … It's not our fault … We want to grow up and live …" The pictures are shown in succession: a pair of bears, a pair of cubs, one lone bear lying on his back, one bear lying on his belly, a mother bear with her cubs. With the pictures, the following scrolling text is added and the whole sequence is coupled with the stanza from Leann Rimes's song *Please Remember*, as shown above.

These juxtapositions of scientific thinking with emotion also drew on the use of music and cadence. The subtitles the girls wrote for the polar bear montage were personal and entreating. The polar bear was presented more as kin (rather than a separate species on a lower hierarchy than humans) with the same needs and rights

as human beings—the right to grow up, to live, to not have their habitats destroyed and be driven to extinction. The girls coupled these subtitles and pictures with specifically chosen song lyrics to hint at the possibility of tragic consequences should the polar bears exist only as a distant memory.

Taking up an Expert Stance: Engaging in the Practices of an Expert

As is evident in our description, authoring an investigation is the idea that the youth had developed understandings of the UHI phenomenon such that they could share these understandings with others in ways that were accurate, supported with evidence, locally and personally relevant, and demanding of attention and action. In this section we examine more closely the ways in which youth took up an expert stance in asserting themselves as CSEs. In particular, the youth engaged in practices of an expert by

- providing a detailed, scientific explanation of UHIs using hybrid discourse;
- supporting their stance on UHIs with multiple forms of data, some analyzed by themselves using technology;
- displaying the attitudes of an expert with their work ethic; and
- presenting their documentaries to an authentic audience with a question-and-answer session

In each of the documentaries, the youth offered explanations of the UHI effect and modeled how it impacts human and environmental health. However, although each video asserted an authoritative stance on the topic, each video also waited until approximately halfway through the documentary to provide a concrete explanation. For example, in *We Be Burnin'* it is at 5:02 (in an 8:44 video) that two of the youth, Michelle and D'Amani, enter the documentary as experts. After the comment "Hmm … they're not sure either … Time to talk to some experts!!" flashes across the screen in response to interviewees who "did not know," the song *The Power* by Snap! (Muenzing & Anziotti, 1990) comes on, followed by the titles "Introducing … The funky funky fresh scientists—Dr. Michelle & Dr. D'Amani." The two girls, while sitting under a shady tree, state the following:

> Michelle: Heat islands are caused when trees and vegetation are displaced by tall buildings and roads. Heat and air are trapped and waste from vehicles, factories and air conditioning. Heat islands are bad for human health. Between 1979 and 1998, more than 7,421, *wooh*!, deaths result from heat islands. What can we do to help out? Cut down the bad effects of heat islands? How are heat islands related to global warming?

D'Amani: Global warming is the warming up of the earth's air and surface, with in-
creased temperatures caused by greenhouse gases like carbon dioxide. Cli-
mate change can affect human health. Habitats can also change so drasti-
cally, that animals can become extinct. For example the polar bears are
dying because it is getting too hot at the North Pole. Weather patterns can
also change like the damage Hurricane Katrina caused.

The formal presentation of the UHI concept in the latter part of the documenta-
ries set up an interesting dynamic with respect to knowing science and communi-
cating ideas meaningfully. It seems that on the one hand, youth wanted to fore-
ground the local residents' and workers' experiences with "heat" in the urban
environment alongside a general lack of knowledge in this area. On the other hand,
such a move positioned them as the experts who provided explanations but situ-
ated them in locally relevant ways because of their insider status as community
members.

As experts the youth also used a variety of representations to educate the viewer
after the stage had been set in the local context. Representations, which served as
symbols, took several forms: scientific representations, such as graphs and figures,
that provided a generalized explanation of the phenomenon under investigation;
cartoon images that caricatured the problem posed by UHIs; pictures of cities that
showed in real terms how the built environment that supports the UHI phenome-
non looks; and images of people and animals that meant to evoke feelings and to
remind the viewer that understanding and taking action against UHIs is a matter of
life and death (see Figure 7).

FIGURE 7   The dying polar bears in *We Be Burnin'*.

In both *We Be Burnin'* and *We're Hot*, the youth offered multiple explanations of UHIs in interview clips that were presented prior to their more in-depth science explanations, such as Ron did in the example with the staffer. This was more evident in the documentary *We Be Burnin'*, in which Kay, the primary interviewer, used the opportunity of interviewing others to also educate them about UHIs and their relationship to global warming. Each time interviewees stated that they did not know or were somehow baffled by her questions, Kay offered an explanation in what appeared to be an attempt to educate and to allow the conversation to move forward their experiences and opinions. In fact, Kay used this maneuver in each of the three interviews presented in the documentary. Thus, being a CSE not only required the youth to have the scientific knowledge base of the UHI phenomenon, it also called for the students to leverage their identities as community insiders. As insiders, the youth had the skills to engage in and facilitate the conversations with their community interviewees, and they strategically drew out from their interviewees the information that was salient to their documentaries.

Being a CSE also cut against the mainstream media's stereotype of low-income urban youth as lazy and disinterested in science. The documentaries showed an active curiosity about the UHI phenomenon and a desire to help others learn about its causes and effects. It is powerful to note that when the youth discussed their products in an interview 5 months after the experience, the very first things they said was that the movies had made them feel important and powerful, and not lazy, in direct contrast to the memes that frame urban youth in popular culture. By authoring the identity of a CSE, the youth displayed the attitudes and work ethic of experts in being strategic, persistent, and meticulous in the production of their mini-documentaries.

> Researcher: Mhmm ... Naomi, how did making the documentary make you feel?
> Naomi: Oh it made me feel proud cuz I know I had put a lot of stuff into movie, in that I actually made a movie, I'm going to be a star ... and like, it's just a great experience ...
> Researcher: Shernice, how did making the movie make you feel?
> Shernice: Um, making the movie made me feel ... it made me feel good to know that I am a super starrer! And I am a movie starrer! And it made me feel really good that I could do a lot of work, and that I'm really not lazy!
> Researcher: Jeremy?
> Jeremy: Well, being the director and the founder of the movie ... it makes me feel very proud that I produced the movie with me FELLOW teammates cuz they were very good too... but you know ... I did A LOT of the work ... I'm so proud ... that the movie can be shown at [the local university]...
> Shernice: Ok, I like the people to think of me as a smart intelligent person, that knows what she's talking about. And, and to think that she's very smart and intelligent.

In an interview conducted 5 months after the completion of the summer investigation into UHIs, youth could still articulate clearly what a UHI is:

Researcher: The movie was about UHIs. What do you know or what can you tell me about what a UHI is? We still start with Jeremy.

Jeremy: An urban heat island is when it's 2–6 degrees more the surrounding areas because of buildings, black cement areas, and not enough green area.

Kay: [interrupting] Wait my turn. An urban island is an island, well not really an island, but it's a place where there is a lot of people so it makes it really hot.

It is worth noting that Kay used her turn in the group interview to stress that UHIs are island-like phenomena in that their effects are felt in a concentrated area, but that they are not really islands. This was a misconception that she, along with many of the youth, had held for quite some time during the summer program.

In addition, after the youth premiered their documentaries to engineers, scientists, and science educators, they were asked some rather easy questions, such as how they felt making these movies. When thrown tough, content-oriented questions such as "Why does restoring buildings help to mitigate the UHI effect?", the youth stood their ground and offered scientific-based reasons, as Shernice did when she answered, "If you restore old buildings, you don't have to cut down more trees to build new buildings ... You could just restore the old ones."

In short, youth asserted their community science expertise in ways that made science talk accessible to others by situating scientific talk and thinking within the workaday lives of ordinary people; within the hip-hop genre of being cool, stylistic, and fashionable; by being playful yet serious; and by linking their ideas and their thinking with serious life-and-death concerns. Furthermore, their talk seem oriented toward taking a stance in terms of taking personal responsibility and action. Figure 8 shows what being a CSE encompasses.

DISCUSSION

We have argued that the youth asserted themselves as CSEs in the figured worlds of GET City by positioning themselves as individuals who were knowledgeable about UHIs and capable of taking action based on this knowledge. Asserting a CSE identity allowed the students a platform in which to engage in scientific ideas and discourses while also offering students the freedom to work and be in their community in ways that mattered to them. Being a CSE was fashioned out of a hybrid discourse that did more than blend the first space of "science" with the second space of the "personal/cultural." It also collapsed the core tensions between being scientific and being agentic that seem to be so prevalent in science-learning settings by allowing students to merge the seemingly contradictory roles of producer and critic. Central to the youths' embodied activities, and indeed their performances, as CSEs, were the dual and often contradictory roles of being a producer and a critic of science. By *critic* we suggest that the youths' actions challenged the
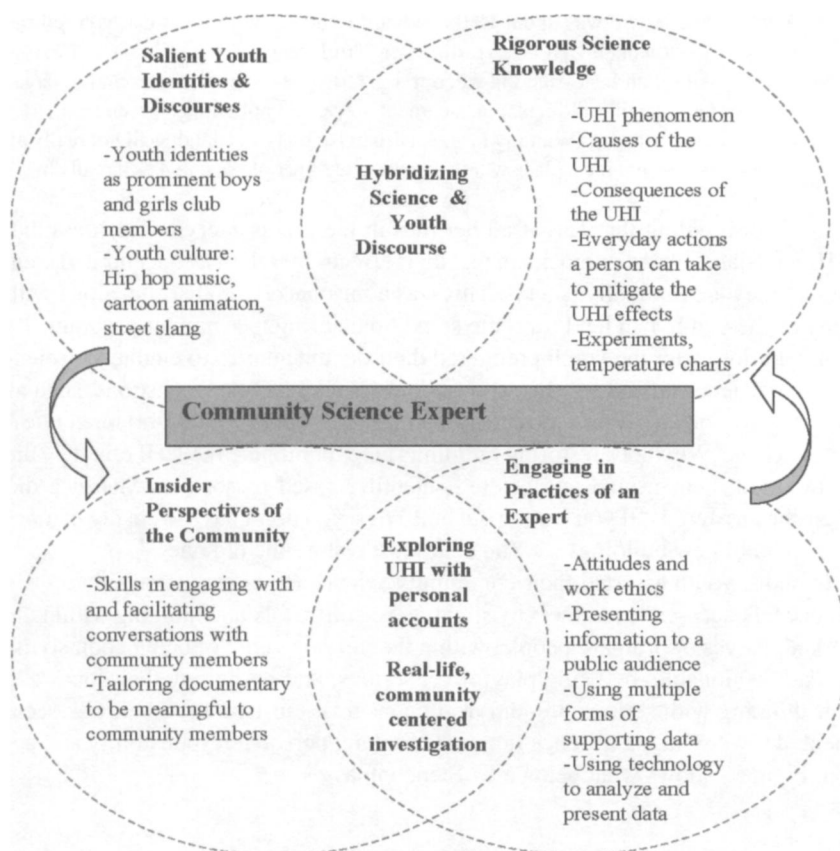
FIGURE 8   Factors involved in being a community science expert. UHI = urban heat island.

normative practices of science. By *producer* we suggest that the youth created new scientific ideas and practices that were defensible. Often being a producer and a critic happen together when one ascribes new meanings to artifacts and symbols.

With their science documentaries, the youth problematized common symbols in science (or things that carry symbolic meaning) and in so doing turned the meanings of these symbols around for their own purposes. One of the symbols was that of a science expert. The master narrative of science as a discipline typically emphasizes the exclusivity and elitism of scientists. Scientists typically belong to an insular community in which specialized knowledge is shared through professional channels such as scientific journals and conferences sequestered from the general public. The notion of a CSE is novel and also antithetical to that of the traditional (or at least stereotypical) scientist. The distinctly circumscribed way of in-

vestigating the physical world in science has resulted in the abstraction of science, making it more alienating to some students (e.g., Halliday, 1993; Lemke, 1990).

In contrast to this established symbol, the youth authored their role as CSEs dialectically with the community members. By situating themselves socially within the community, the youth were able to coconstruct such an identity as the CSE. By engaging in conversation with community members, the youth shared ideas about UHIs that helped to shape both subsequent interviews the youth conducted as well as their own understanding of the UHI phenomenon. In somewhat similar ways to the youth in Jurow, Hall, and Ma's (2008) study on recontextualization models in conversation, by creating opportunities to engage in authentic dialogue with community members, the youth in our study were able to further advance and situate their explanations of UHIs.

Another symbol the youth critiqued and transformed involved the ways in which scientific ideas were communicated and represented. Scientific language is often rendered as dense, technical, and abstract. The abstraction of science works especially to obscure concrete life experiences into conceptual entities and generalizations. In all three documentaries, we see that the youth instead chose to specifically place their scientific ideas in context and to situate the meaning of their knowledge claims rather than to represent ideas removed from context. *Da Heat* presented specific cities with a pronounced UHI effect, such as Atlanta and New York City; *Da Heat* and *We Be Burnin'* focused on a specific animal victim of global warming—the polar bear—using pictures that evoke visceral responses removed from the objectivity of science. *Da Heat* also featured photographs of a man riding his bike as opposed to driving, and children planting trees to ameliorate the UHI effect. All three documentaries offered specific suggestions individuals can take to take steps toward mitigating the UHI effect. With these forms of representation, the youth succeeded in localizing the seemingly remote concept of the UHI.

Specific contextualization and situations positioned the youth as both producers and critics of science rather than as mere recipients of scientific ideas. This is further emphasized by the language in their movies, which was heavily grounded in youth genre that stresses the dramatic. We see this operating on two different levels. The youth inflected the text they used in their documentaries with youth linguistic practices, such as slanging. Although B. Brown's (2006) minority students concluded that "it isn't no slang to be said about [science]" (p. 119) in expressing the discursive conflict they experience with science, the GET City youth succeeded in negotiating for expressing their science ideas in their own ways. This can be seen from the movies, especially with the titles *Where da Heat Go?* and *We Be Burnin'*. The youth were also very particular about how they wanted the phrases spelled and structured. When first creating the title *Where da Heat Go?* we had been working with the group to show them how to insert titles into i-movies. When they said that their title should be "Where da Heat Go?" we incorrectly mis-

interpreted them and then by way of demonstrating titles typed in "Where did the heat go?" We were immediately corrected that it is not "the" but "da." So we re-typed "Where did da heat go?" and after much laughter we were corrected again, this time with Shernice doing the typing: "Where da heat go." She told us it has to be that way because whenever it is hot out and she is in the car with her auntie, she would always say "Where da air go?" in reference to her nonfunctioning air-conditioning system. In critiquing both symbols, the youth were emphatic in bringing in identities and relationships salient to them—being popular and sociable young adults who speak their own youth-centered language.

These forms of youth speak were evident in students' formal scientific explanations as well. When serving as the UHI expert, Ron broke his cadence of science talk to interject comments regarding how the heat makes you crazy: "An urban heat island is where the air temperature in the urban areas is higher than the rural areas." Ron then looked at Kaden who was off camera, smiled, and said, "People are makin' faces! I'm gonna getcha." Then Kaden, who was still off camera, could be heard saying, "I recorded that!" Without hesitation and with two fingers pointing at the camera, Ron said, "See, this is the effect that you get [from a UHI] cuz people act crazy and insane! The four causes of heat islands are green house gases, displacing trees and vegetation, tall buildings and narrow streets, and waste heat from cars and businesses."

This break in cadence shifted the mood and location of science expertise to be both playful and everyday. This disruption in the traditional science discourse was evident in the other two video documentaries as well. As discussed earlier, both *We Be Burnin'* and *da Heat* used playful, funky science characters to introduce scientific explanations. Thus, through discourse and discourse disruptions, the youth transcended the technical cadence and register of canonical science and in the process claimed a sense of ownership over the science content.

In producing and critiquing science through the process of making a science documentary, the youth were able to negotiate, within the affordances and constraints of the Get City figured world, to momentarily transform their engagement with science. They problematized established symbols of science, authored alternative identities, and displayed agency in their transforming acts that challenged how science should be presented, contemplated, and understood not just among their peers but among the general public, because the youth were clear in their intentions that their movies were "not just for kids, but for everybody."

CONCLUSIONS

The youth in GET City expressed agency with and in science in how they worked to identify and position themselves vis-à-vis the figured worlds of science, their community, and GET City. We have argued that to enact agency with and in sci-

ence, youth drew upon a knowledge of UHIs alongside culturally and socially situated explanations for why UHIs matter and how such concerns might be communicated to others. We have also argued that these understandings were grounded in a critical appreciation of students' communities, of students' world, and of the role that science can play in them.

To return for a moment to our conceptual framework, we can see how youth engagement with both the vertical and horizontal dimensions of learning were iterative and generative. Developing understandings of UHIs positioned the youth to engage a broader audience through practices horizontally carried from home communities into science, such as how they meaningfully paired content ideas with specific pictures and music selections. Likewise, the youth strategically engaged area workers and residents in personal accounts that valued their experiences while simultaneously reframing these experiences in light of the scientific accounts of the UHI effect. Learning is not just about developing the practices of experts, as described in vertical learning; it is about recreating those practices in locally meaningful ways. This stance on learning demands that we consider the role of agency in youth development.

We see that youths' efforts in enacting agency with and in science worked not only to transform their participation in the figured worlds of science, community, and GET City but also to enlarge/transform their identities and spheres of activity and influence within these figured worlds. To enact agency with and in science, youth drew upon resources and relationships available to them *across* their figured worlds in order to expand what they could do within any of these worlds. They used these resources and relationships to reposition themselves within these communities. At the same time they also worked to transform the communities themselves.

Their ideas about studying "real" UHIs rather than only models of them positioned the youth to engage real community members in actual dialogue about UHIs. They talked with legislators, police officers, capitol workers, and residents. They were surprised, with few exceptions, that almost no one in their city knew much about UHIs. In fact, they pointed out when these individuals had incorrect assumptions about UHIs.

By producing high-quality science documentaries intended for audiences broader than themselves, the youth positioned themselves to speak to a wide range of communities that have influence over scientific, political, and educational work. Through a sequence of events with somewhat of a snowballing effect, the youth eventually presented their work to engineers, scientists, science teachers, state representatives, and community foundation officers and rubbed elbows with people who were generally outside their worlds. Their work even provided the evidence needed to win a local foundation award to support doubling the size of the club's mobile learning lab. These activities also further worked to increase the students' visibility and status in the club. By presenting their work to a group of local scien-

tists, engineers, and educators, the youth also expanded their access to the science community. Several of the scientists and engineers were so moved by the documentaries that they have donated time at the club to talk to the youth about professions or to help out with activities.

We also believe that the stories presented in this article suggest that the process of enacting agency also involves a process of *co-opting* activities to allow youth to express who they are and want to be in ways that meaningfully blend their social worlds with the world of science. This advances us beyond the structure–agency dialectic, for it shows how youth engaged science both as a context and as a tool for change. Yet we also believe that their performances in GET City worked toward a complex set of goals that were much more complicated than we had initially conceived or that we could even discern from our locations as relative insiders/outsiders. Our program was designed to offer youth opportunities to engage in advanced IT and the science of green energy technologies in ways that built upon their social worlds. We began the project with the hope that we might, somehow, craft with youth such blended or third spaces, allowing them the space and maneuverability to be both scientific and youthful and to feel empowered to take some action beyond themselves. Yet having unpacked youths' enactments of community science expertise and their negotiations of the tension inherent therein, we believe that their participation was more complex in the sense that many of the participating youth strove to make their knowledge claims—about UHIs and the nature of science—accessible to a wide range of community members, a desire we had underestimated. Furthermore, we observed an intensity around their desire to be the CSEs on UHIs, with an ownership and a curiosity about the phenomenon. We had hoped they would engage this topic but had not anticipated them staking an identity within it with the intensity and influence that they did. Finally, we noted that the youth often struggled to balance their newly asserted identities with their new visibility in the club. From actions such as Jeremy strategizing how to carry his computer from the conference room to the Club room (open and with the song *Peanut Butter Jelly Time* by the Buckwheat Boyz, 2000, playing loudly), we learned how the youth sought to make this delicate balance advantageous to them. And yet we were surprised by how some of these balancing acts challenged our own assumptions of youth participation, such as the time that Boss Doss wanted to be sure that her cameo as the funky funky fresh scientist was shown in the early fall recruiting meeting to nearly 100 youth.

The GET City youth showed themselves to be purposeful and strategic learners in science. By actively negotiating for the form and function of their participation in GET City, the youth show the complexity inherent in enacting critical science agency and the disservice that is done to them by restricting the range of their expression of and engagement with ideas—a restriction that occurs, more often than not, within the strictures of the traditional classroom. Genuine engagement in science learning demands that science educators attune themselves

to the multifaceted learning possibilities that are created when they frame learning as agency.

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