Cult Scie Edu (2007) 2:441–473
DOI 10.1007/s11422-007-9062-0

ORIGINAL PAPER

Describing students of the African Diaspora: Understanding micro and meso level science learning as gateways to standards based discourse

Ed Lehner

Received: 10 May 2007 / Accepted: 10 May 2007 / Published online: 13 July 2007

Abstract In much of the educational literature, researchers make little distinction between African-American students and students of the African Diaspora who immigrated to the United States. Failing to describe these salient student differences serves to perpetuate an inaccurate view of African-American school life. In today's large cities, students of the African Diaspora are frequently learning science in settings that are devoid of the resources and tools to fully support their success. While much of the scholarship unites these disparate groups, this article details the distinctive learning culture created when students from several groups of the African Diaspora learn biology together in a Brooklyn Suspension Center. Specifically this work explains how one student, Gabriel, functions in a biology class. A self-described black-Panamanian, Gabriel had tacitly resigned to not learning science, which then, in effect, precluded him from any further associated courses of study in science, and may have excluded him from the possibility of a science related career. This ethnography follows Gabriel's science learning as he engaged in cogenerative dialogue with teachers to create aligned learning and teaching practices. During the 5 months of this research, Gabriel drew upon his unique lifeworld and the depth of his hybridized cultural identity to produce limited, but nonetheless important demonstrations of science. Coexistent with his involvement in cogenerative dialogue, Gabriel helped to construct many classroom practices that supported a dynamic learning environment which produced small yet concrete examples of standards based biology. This study supports further investigation by the science education community to consider ways that students' lifeworld experiences can serve to structure and transform the urban science classroom.

Keywords African Diaspora · African-Americans · Cogenerative dialogue · Creolized practice · Identity · Lifeworld · Suspension center

E. Lehner (✉)
Graduate Center, City University of New York, 365 Fifth Avenue, Room 4202, New York NY 10036, USA
e-mail: EdLehner@aol.com

Introduction

> If Biggie or Jay-Z were rapping about environmental science or biology, me and my peers would be geniuses...I'd be good. Now, I know it's important to learn and but it ain't the type of "know" that gets me up to study. Instead my world- the black/ Latino world- and hip-hop culture is focused on the things that are going-on in the hood. And science, well, it don't even involve me. I ain't much concerned with it and science don't seem to notice me neither. (Gabriel, interview, May 15th, 2006).

This quote captures Gabriel's indifference about the state of his science learning. Gabriel is a bilingual, 17-year-old who describes himself as black-Panamanian and he is presently a junior at Liberty High School Suspension Center in Bushwick, Brooklyn. He is making strong educational progress in his courses and is actively involved with the school's student government and other extra-curricular activities. As he readily shares, Gabriel has been intellectually stimulated from a young age in his bilingual Panamanian-American home in East New York, Brooklyn where he lives with his parents and three younger brothers. His high grades on his academic transcript and the complimentary reports from his teachers attest to his intellectual capabilities. According to all relevant academic indicators, Gabriel is an intelligent, college-bound student, who has a natural inclination for learning and language. Nevertheless, Gabriel self-reports as underperforming in science, maintaining a grade that is 15 points lower in his biology course than his overall academic average. In an interview, Gabriel stated, "I've always had problems with science. You know, the way it's taught. The language, those labs, the rules. It's all too formal." What is indistinct and unarticulated by Gabriel is the extent to which he can fully access the consequences of his decision not to completely exert himself in the learning of science and what it may mean for his future academic and career choices. Commenting on his future in science, Gabriel said, "If science happens for me ... then good. If not, I'll find something to study and do as a job."

Why students of the African Diaspora and not African-American?

Gabriel typifies an entire population of students who are unaccounted for in most of the education literature. Although he may dress and speak like most of his African-American peers, Gabriel is a member of a growing group of students who characterize the diverse incarnations of the African Diaspora. Spring (2004) contends that race is often a political construct in American education rather than a meaningful descriptor that reflects the complexity of the grouping. Rather than describing race in this political way, educational researchers should distinguish between students who are African-American and those who represent the African Diaspora in all of its manifestations. In the research I have been involved with in New York City, science learners represent the wide-ranging array of the African Diaspora which include first and second-generation Dominicans, Haitians, Jamaicans, Guyanians, Panamanians, Puerto Ricans, Trinidadians, and Cayman Islanders. Some aspects of unique culture possessed by each group can be hard to fully describe because students who represent the African Diaspora are simultaneously assimilating into the larger urban African-American and white culture.

I raise this issue because much of the literature on urban science education approaches the topic of race from a narrow, primarily bifurcated perspective, in that students are either African-American or white. While scholars in educational research still describe the world

in this antiquated fashion, large metropolitan areas are being transformed by immigration. Only a small percentage of today's scholarship describes the urban reality of the African Diaspora as lived out in cities like New York. Instead, much of the literature still portrays African-American students in urban science classrooms as American-born students who primarily live in conditions of poverty. In addition to not accounting for the large number of African-Americans who are gainfully employed, these portrayals also do not report the growing number of students from the Caribbean, South America, and Africa who are in American urban schools. Moreover, a large percentage of this research does not mention the familial histories of students of the African Diaspora and how the students' homeland cultures can assist in their learning of science.

I encountered this complex issue while trying to describe the students involved in this research. The apparently straightforward category of "African-American" did not reflect the rich diversity of the students of African heritage represented in New York City and specifically those who were involved in this research. Of Liberty High School's 100 pupils, the school's official roster records the demographic population as 70% African-American, 36% Latino/Latina and 4% Asian. Of the 70% who are described as African-American, in one-on-one conversations, many of these same students openly talk about their immigrant heritage that represents both the historical and present day Diaspora of African migration.

The problem of describing the participants in our study became clearer when I spoke with them about race and ethnicity. After such discussions, only a few of the student/researchers describe themselves as African-Americans. Most of the student/researchers were hesitant to use the term "African-American" because in their respective neighborhoods, their distinguishing ancestry was often highlighted. Distinct from the traditional view of African-Americans, students of the African Diaspora are often ethnic "others" in New York City. After one discussion about race, Clive said, "I am still that Haitian dude. I live in Bushwick. I grew up here. But, I am still the Haitian." To white America, Clive is African-American, but in his own neighborhood he is still considered ethnically different than his African-American peers. Clive does not describe himself as African-American because he sees and appreciates the unique aspects of his Haitian background. Unfortunately many researchers fail to acknowledge the distinct aspects of students of the African Diaspora and continue to categorize students like Clive under the simpler, African-American rubric.

Dispositions and hybridized identities

Throughout the research, Clive continued to negotiate/renegotiate his understanding of both his cultural and scientific identities. In his work on cultural identity and the African Diaspora, Hall (1990) argues for viewing cultural identity as constantly being in the state of production rather than being fixed. Hall's conception of cultural identity being produced was particularly salient for many of our students who were grappling with their respective sense of both their cultural and scientific identities. For example, Clive's comments speak to his perception of his changing cultural identity and in his lifeworld he attempts to find a way to hybridize his Haitian ways of being into the larger urban culture.

Using Boykin's (1986) dimensions of black culture, recent science education scholarship has described African-American learners as being prone to enact specific cultural dispositions while learning science. This framework repositions the issue of urban science learning from a deficit perspective, but at times, this construction is still too narrow to

capture the complexity of classroom learning as enacted by students who represent the array of peoples and cultures of the African Diaspora.

Despite Boykin's theoretical value, his dispositions of black culture do not capture the complexity of classroom life because it only positively typecasts urban youth culture. While students of the Diaspora enact many positive dispositions, Boykin's framework cannot address the contradictions that arise and it is not sufficiently refined to address social life as it is occurs in schools. As seen in Roth and Tobin's work (2002), researchers need to acknowledge and utilize the contradictions that occur in research, not minimize or explain them away. By strictly adhering to Boykin's framework, scholars may inadvertently frame social life in urban schools with subtle determinism. While urban students are apt to enact some aspects of black culture, research rooted in Boykin's framework is often theoretically ill-equipped to provide a clearer understanding of students' motives. This type of research merely describes student dispositions without explaining the grounds for such actions, leaving practitioners and researchers to continue positive stereotyping. Although Boykin's focus is on dispositions, nonetheless his work does not adequately address the ways students grapple with identity change. In terms of recognizing how African-American and African Diaspora students understand shifts in their scientific identities, a more robust, theoretically sophisticated lens is required to frame the complex procession of cultural production and reproduction.

Moving away from dispositions and toward hybridized identity and creolized practices

Employing an approach that is grounded in the daily research and teaching in a New York High School, I recognize that students of the African Diaspora have tendencies to act in-line with Boykin's dimensions of black culture. Acknowledging the dispositions of black culture, I utilize Roth's conception of hybridized identity to elucidate the motives inherent in students' actions because it more closely reflects the enactment of school life. Understanding that urban students are continually searching for ways to interact with the science curriculum and the larger society, Roth (in press) writes that the hybridized identity is a way that students of the Diaspora attempt to find a "home" away from home. Noting that forced or volitional emigration from Africa as Diaspora, and the cultural process of finding a home away from home as the hybridization process, Roth describes hybridized identity as a way that students of African heritage deal with hegemony.

When a person is physically removed from his ancestral homeland, he is subsequently engaged, often unconsciously, in developing a hybridized identity as he attempts to assimilate into mainstream culture without losing the distinctive aspects of his native culture. Whether hybridized identities are formed over a course of centuries, as is the case with African-Americans, or over a few years, as with Gabriel, the hallmark of these identities is the sophisticated amalgamated practices utilized to interact with hegemony.

For Gabriel, the development of his hybridized identity required that he straddle between his parents' Panamanian culture and his new life in Brooklyn's East New York. During an interview, Gabriel alluded to facets of his hybridized identity when he described the complex ontologies that he employs at home and in his neighborhood. In Gabriel's case, the process of hybridization serves social and familial purposes. For instance while growing up, Gabriel pointed out that he wanted to fit in and be accepted by his peers but this often meant hiding aspects of background. "Like, I learned quick not to talk with a

Spanish accent. My family still speaks Spanish at home and so do I. But in my neighborhood I spoke straight hood from day one. A lot of my crew still don't know that I am Panamanian."

As illustrated in this quote, Gabriel felt the need to adapt his speech contingent on whether he was at home or with his peers. The hegemony of Brooklyn's neighborhood life has encouraged Gabriel to incorporate more localized ways of speaking that differ radically from his home culture. Gabriel's experiences demonstrate the progression of hybridization where he engages in a complicated process to navigate hegemony. Incorporating aspects of both Panamanian and Brooklyn life, Gabriel produces a creolized ontology through the hybridization process. For both African-Americans and African Diaspora students, the hybridization process continually generates new forms of creolized culture.

Hybridization yields hybridized identity and creolized practice

The issue of hybridized identities and hybrid practices are at the center of my research because our students are relentlessly using their supplies of knowledge acquired from their native countries, their parents' homes, and local neighborhoods, to make sense of the curriculum. While struggling to learn biology and excel academically, our students engaged in a hybridized form of learning science. Roth describes hybridized identity as the process of integrating local approaches of learning and speaking with canonical discourse. Due to on-going globalization, Roth argues that many immigrant students are faced with a need to create hybrid practices in order to learn science. To communicate, these immigrant students utilize various languages and skills for the practical purpose of interacting with the science curriculum. Faced with the often hegemonic structures of learning science and immersed in urban culture, our students often used metaphors, similes, and manufactured creoles to make meaning of the biology curriculum.

Building on Roth's (in press) writing on hybridized identity, I describe the fusing of racial and ethnic characteristics as representations of the hybridized identity and not as cultural identity or dispositions of black culture. Hall's and Boykin's conceptions of cultural identity and dispositions are helpful notions, but neither capture the complex enacted culture in today's large urban centers. For instance in addressing Hall's conception of cultural identity, the students of the African Diaspora in this study mostly share a common component of being different from African-Americans rather than sharing a universal Caribbean identity. Boykin's work is too closely tied to tendencies to enact proscribed culture that such conceptions are unable to describe students' needs to creolize and adapt practices to benefit their learning.

Hybridization and hybridized understandings of identity

Representing different home countries and familial histories, the conception of hybridized identity captures the complex experiences these students face in learning science in an American urban school. Although our students would not typically describe themselves in hybridized terms, their conceptions of their own individual racial identities are consistently being defined by their differences, rather than by a shared cultural identity. For example, when I asked Hamilton if he were African-American, he said playfully, "Why son? Don't I look black to ya?" After sharing a moment of laughter more with his peers than me, Hamilton continued:

> Naw, Mr. Lehner, I am just playin. Can't you tell? I am a "blacktino." Latino! Latino baby!!! I speak Spanish...I eat rice and beans. I love Latin honeys. But I am black. My pops is black. We all Dominican. And, I rep myself like I am black. I can bang (*an expression for fighting*) son! Hold my weight (*a phrase meaning that he is tough*)... Damn it! I don't play. Ya got to have a rep in the hood and I got that.

Hamilton describes himself based on his difference compared to the larger African-American community. In Hamilton's understanding of himself, a dual identity emerges both as a Latino, specifically Dominican, and as a black male. He fuses the distinct characteristics of race and ethnicity into one hybridized identity, merging aspects of the distinct culture passed on to him from his parents and their homeland and his new home in Brooklyn. In the transcript above, Hamilton first identifies with his family, his language, and representations of his culture. He also understands himself as black because of his skin color and the fact that he can "bang" or fight. Being a young man who grew up in a rough neighborhood, Hamilton resonates with the need for street creditability and toughness. He also represents this aspect of street creditability by saying, "I rep black," referring to his self-representation as black, rather than his signifying ethnic ties.

With regards to being identified as an African-American, Hamilton never mentions the term unless I first use the phrase. During group and one-on-one interviews, the students rarely employed the phrase "African-American" as a self-descriptor. The student/researchers first spoke of themselves as black, even if they were born abroad and then, addressed their ethnicity. As seen above, Hamilton uses "blacktino" both as a racial and as a cultural descriptor. Because of cultural otherness in New York City, many of our students situate their hybridized identities in African-American youth culture but show reluctance to solely identity themselves as such.

As with Gabriel, Clive, and Hamilton, I have noticed that there are many similarities in these young men's lives. However, there are also important differences among their family's histories and countries of origin that need to be detailed. For instance, Hamilton is a third-generation Dominican-American, whereas Gabriel is a first-generation Panamanian who is presently studying to become a United States citizen. In detailing the racial and ethnic richness of the students who participated in this study, the descriptions more accurately capture a range of racial and ethnic scope that is often left out when students of the Diaspora are simply described as African-American. By making these distinctions, I think it better defines the complexity reflected in New York City's schools. Such descriptions can help elucidate important aspects about these students, such as where their educational strengths lie, and in what ways educators can possibly build upon their natural abilities to facilitate science learning. Rather than describing African-Americans as a group in hegemonic, opaque, universal ways, I attempt to specify the unique blending of varied cultures that exhibits the African Diaspora and how the dispositions of members of these different groups are enacted in the science classroom. Acknowledging that there are different descriptions of this migration, I explain that students of the African Diaspora represent both the historical ancestors and the present-day African immigrants. For instance, while I will detail the particulars of a student/researcher's background, I describe both Clive, a second-generation American from Haiti, and Akeem, a new immigrant from Kenya, as students of the African Diaspora.

Such vivid and fuller descriptions are needed to accurately depict our student/researchers. Like Clive and Hamilton, all but one of our student/researchers' parents were born and raised outside of the United States. Six of our seven students' families represent countries with languages other than English, diverse histories, and distinct ways of being in

the world. Our students often spoke about their parents' homeland in fond ways and, at times, described in detail their visits to Haiti, the Dominican Republic, Grenada, Jamaica, and Panama. Of our seven student/researchers, four were actually born in one of the countries mentioned above.

Describing the study, site and participants

While this ethnography focuses on Gabriel and his biology learning, the larger context of this study occurs in a New York City High School Suspension Center. Located in the Bushwick section of Brooklyn, Liberty High School Suspension Center is a vibrant learning community where 100 students regularly attend. The school is unique in that it has been created to instruct suspended students from the boroughs of Brooklyn and Queens who have been recently released from their primary institutions because of disciplinary problems. Suspension Centers are alternative schools where students receive their education while serving a yearlong expulsion for committing a serious disciplinary violation.

As demonstrated in their respective schools and communities, many of Liberty High's students are bright young people who are academically and socially skilled. Despite all of their abilities, nearly all Liberty High students are greatly at-risk of dropping out of school or being incarcerated. Attributed to some factors beyond their control, the students' academic risks are often due to macro level problems such as attending elementary and junior high schools with histories of staff shortages and long track records of providing insufficient instruction. Beyond the risk of having received their primary education in inadequate schools, nearly all students at Liberty High are involved with New York City's Juvenile Justice System because of alleged criminal activity or due to police involvement during the event leading to their suspension. Many of these students are at-risk of incarceration because of their volitional choices that have placed many of them in trouble with the law resulting in their being placed on either probation or parole.

Considering additional risk factors, many of Liberty's students are under-credited for their age and in need of special education services. First, nearly all Liberty High students are under-credited and over-age for their respective grade and are in jeopardy of not finishing their high school degrees on time. The typical New York City high school student progressing on grade level will accrue 10 credits per academic year. Many students arrive at Liberty High School with few earned credits compared to the years they have spent in high school. For instance, it is typical for students to arrive at our school in their third year of high school with only two credits, whereas an on grade level student should have nearly 20. The lack of credits puts these students at a profound disadvantage and many, thinking that graduation is unlikely, resign themselves to not learning, or at some point in their suspensions, decide to drop out of school entirely. Another unique risk factor for Liberty High School students is their need for special education services. Over 1/3 of the students, 38 of the 100, are classified for special education classes. In spite of this overwhelming ratio, the school does not have enough staff to fulfill the goals set out in the students' Individualized Educational Plans (IEP). Even though student IEP services are federally mandated and New York State regulated, Liberty High has neither the staff nor the educational intention of meeting the stipulations of these mandated student services.

Lastly, many students who finish their suspensions at Liberty High have difficulty reintegrating themselves back into their sending school's culture after being separated from their peers for a full academic year. This interruption in their normal schooling often delays

the accomplishment of peer appropriate milestones such as playing a sport at their school, participating in after-school activities, preparing for the Scholastic Aptitude Test, or applying to college. Return to their sending schools after successfully completing a year's suspension, many students are disadvantaged from progressing to vocational or college settings because Liberty High is not equipped to assist students in the post secondary application process.

The biology class and our use of cogenerative dialogue

This research documents the teaching and learning of biology and the use of cogenerative dialogue in a required New York State high school class. Seven Liberty High School students, including two special education learners and two teachers, met to co-plan, co-author and co-implement learning and teaching strategies over the course of one semester. The class was organized under the inclusion/special education model where students with learning disabilities are integrated into a mainstream class. The group included four males and three female students and two teachers. In terms of the teachers, Larry Seeram is a certified New York State science teacher and he was our biology content area expert. Being certified in Special Education, English and Social Studies, I served in the capacity of the special educator in this class providing inclusion services to our special education population and coteaching the biology curriculum. Because of the unique behavioral and emotional needs of Liberty High students, all course sections are capped at 15 students and many classes have less then 10 students.

Our biology class met daily for one full semester and each week we institutionalized the practice of cogenerative dialogue at the end of Wednesday's class. Roth and Tobin (2002) established the practice of cogenerative dialogue as a way for students and teachers to talk about the learning and teaching practices in science classrooms. Tobin (2005) describes cogenerative dialogue as a conversation participants have about a shared experience, often a science class, and the purpose is for members to take collective responsibility for the results of the classroom. Before ending a cogenerative dialogue, participants "co-generate" a plan of individual actions geared toward improving classroom teaching and learning. Theoretically, cogenerative dialogues are intended to provide the social space for classroom stakeholders to produce unique culture that meets the needs of their specific learning environment. By meeting consistently, cogenerative dialogue can become a cooperative field where students and teachers can transform classroom instruction and learning by aligning the needs of all involved.

The design of the study

This study was designed as a longitudinal critical ethnography concerned with the ways that students identified as, or disassociated themselves from, being learners of biology. Particularly, this study was focused on creating transformative learning opportunities that could mediate students' learning, and possibly, positively affect their identities. The students took part in this research over a 20 week semester spanning 5 months, from September 2005 to January 2006. As outlined in the Belmont Report (1979), this research focused on minimizing potential harms, maximizing participant beneficence, and creating a sense of justice for all those involved. Additionally, this work adhered to Guba and

Lincoln's (1989) authenticity criteria by focusing on student approaches that they could practically make use of in order to benefit their science learning. All involvement in this study was voluntary and invitations were extended to all students who wished to participate.

Catalytic authenticity

Of all of our outcomes, Larry and I intentionally focused on catalytic authenticity because we believe that if the student/researchers practically understood that their research efforts could positively influence their learning, they would become more fully engaged. By turning our research attention to promoting participant learning and acquiring science skills that could be readily used, we attempted to build a strong sense of catalytic authenticity into our work. To this end, student/researchers were encouraged to think about ways to make the practices of biology more inclusive and the everyday learning and practices more accessible. In doing so, students were exposed to an idea of pedagogy that focused on science inclusion and they often acted as cultural brokers mitigating between canonical science and their urban lifeworld. In cogenerative dialogue and in class, teacher/researchers would often ask participants: "how would you retell/re-describe this process so that your peers could more easily understand this?" In promoting these types of exchanges, student/researchers often expressed that they felt comfortable suggesting new ideas. In this way, catalytic authenticity was stressed by allowing the student/researcher to promote lifeworld practices that would facilitate learning for all members and which helped them meet the science learning standards.

Data resources

The student/researchers and teacher/researchers analyzed the ways that students normally interacted with new biology material and re-analyzed similar learning interactions after cogenerating ways of integrating the material into their lifeworlds. Attempting to create more student learning opportunities and empowering their in-class science experiences, participants in this research were engaged in many distinct roles. For example in this project, students served in the capacity of biology learners, lab participants/peer lab consultants, cogenerative dialogue members, curriculum advisors, and as colleagues/stakeholders. While students were engaged in these varied roles, they were simultaneously learning biology in a class required for graduation.

In all stages of the research, much of the data were collected via digital video tapings of the cogenerative dialogues and classes. Regularly student/researchers and teacher/researchers would view the video in *i*Movie on a Macintosh PowerBook G4. Additionally, student interviews, notebooks, labs, and test results were also used as data resources.

Over the course of this ethnography, our study examined the learning and teaching practices on the micro, meso, and macro levels over the 20 weeks of the course. First, we looked at micro interactions in the classrooms by manipulating time with the use of digital video equipment. Micro interactions were studied by using software to slow down interactions, replaying portions, or speeding-up the video in order to examine the fine points of the activity. We also looked at meso level interactions that occurred in real time and space as social life was being acted out. Lastly, we examined macro level themes that we saw enacted by multiple participants over the entire course of the semester and that were

evident in the video tapes, individual interviews, classroom notes, and periodic tests. Our inquiry into these distinct layers of social life seeks to understand the dynamic elements of social life as they are produced.

Creating ways to include all students in science instruction

Often, the most pressing problem in teaching science in urban areas is making the curriculum and the associated practices accessible to all learners. Martin (2006) writes that in many public schools the daily science education persists to accommodate only a small group of students who may in fact already have some natural aptitude in the related scientific disciplines. Often this form of teaching leaves the majority of school learners excluded from meaningful instruction and may do more to alienate students from engaging in the learning of science. Martin's point builds on Barton's (1998) notion of a "science for all" where egalitarian learning and teaching practices can create spaces for more students to enjoy and benefit from the related disciplines. However, in much of the public school instruction, an antithesis of "science for all" lives in the curriculum and frequently estranges students from science at a young age. Furthermore, and perhaps more importantly, students frequently do not learn science in unrestricted ways because many learners already think of themselves as non-achievers and this perception can get perpetuated and solidified as their respective scientific identities.

While comparing the science education literature with my classroom experiences, I see a common element that students, almost always at early ages, learn that science is "not for them." When Larry Seeram and I started our project, we began with the idea that science is for everyone; we embraced the thought that science was for Gabriel and for all of the students in our classroom. For many science teachers, students like Gabriel and science achievement are mutually exclusive. This is the case with one of Liberty High's biology teachers, Foreman (a pseudonym), who readily acknowledges Gabriel's intelligence but attributes his indifference to biology to a lack of enthusiasm and previous knowledge of the subject matter. In fact, Foreman taught Gabriel's biology class in the semester preceding our research. In conversation, Foreman enthusiastically expressed his opinion that Gabriel was unable to learn the content. At times, like Foreman's appraisal, many science teachers may underestimate student strengths and capabilities. Foreman's assessment does not address why so many students, especially in large urban areas, are disinterested and disengaged in their respective science curriculums, and yet many of these same students achieve on grade level in their other courses. Gabriel is such an example since in all other subject areas, except science, he achieves on grade level.

Unaddressed learning needs is one salient reason why students like Gabriel can sustain a 90 average in most of his course work but maintain only minimal passing grades in science. Coining this phrase "discourse of invisibility," Rodriguez (1997) wrote that the National Research Council's science education standards do not explicitly address issues of ethnicity, race, gender, or socio-economic status, and the fact that each respective group has unique needs in the learning of science. In fact, students like Gabriel are most fully disadvantaged because he operates under the assumption that he is following all the rules and is underachieving due only to his lack of effort. And while it may be true that Gabriel is underachieving because he often does only the minimum amount required, there has been no explicit school discussion centering on his need to learn and thrive in science courses. Gabriel functions under the belief that all potential professions, science careers

included, are open to him and that all he needs to do is fully apply himself. Unbeknownst to him, due to his poor science-related attainment, Gabriel may be precluded from upper level high school courses, college preparation tracks and, inevitably, a science-related career. His peers in New York City, the United States, and around the world, are already preparing and acquiring the needed skill-sets, basic science understandings, and rudimentary coursework to groom them for futures in science.

Understanding micro, meso, and macro enactments of biology

With micro, meso, and macro enactments of biological learning, I see a leveled progression towards fully engaging in science. These actions include a motivation for achievement and an engaged frame of mind geared toward academic success. Micro level biological displays are behaviors that are engaged learning actions but contain little evidence of science. Examples of such behaviors include participating in lessons, attending classes, taking notes, and affording respect to teachers and fellow students. Meso level biological displays are behaviors that are conducive to creating an engaging learning environment but also demonstrate individual collective commitment to learning the biological discourse. Instances of meso level biological learning performances include student initiated learning strategies, suggestions to improve learning and teaching, or attempts at creolization where standard science discourse is conjoined with vernacular speech. Student micro, meso, and even macro science displays can be described as creolized science where the students are demonstrating learning behaviors or articulating science concepts in their lifeworld discourse. Micro and meso forms of creolized science are conceptualized as essential gateways to macro level enactments of science.

Drawing from Hall's (1990) and Roth's (in press) ideas on creoles, I use their theoretical perspectives in my analysis of the data from this study. Student/researchers and I closely examined classroom behaviors and coded them as micro, meso, or macro level science demonstrations. In my analysis of the data, I exclusively detail Gabriel's progression from micro to meso forms of science discourse. Using Roth's (2005) conception of zooming and focusing, I found patterns of coherence where Gabriel displayed micro and meso level demonstrations of biological knowledge. I zoomed-in on Gabriel's learning behaviors over the course of the 5 month study and described some of the salient findings in this work. As the study evolved, Gabriel went from demonstrating micro level science learning behaviors to fully exhibiting meso exhibitions. Even though he struggled with articulating science concepts fluently, Gabriel's efforts are a profound step in addressing the discourse of invisibility (Rodriguez, 1997). By sanctioning his creolized forms of science, Gabriel concurrently advanced from micro to meso science demonstrations.

Gabriel's demonstrations of micro and meso science

The first vignette is taken from a cogenerative dialogue taped early in the research. During this cogenerative dialogue, I started the session by formally stating the rules of cogenerative dialogue: (1) show respect to other group members, (2) one person speaks at a time, and (3) we must "co-generate" something that we collectively bring to the class to improve learning. During this session, Gabriel and Clive were very engaged as we started to talk about the ways we could collectively improve the learning in our class. The emotional

energy was high throughout the 16 min of our meeting as evidenced in the mutual focus, shared mood, and detailed attention to the topic at hand. I remember thinking that the meeting had gone well when we finished taping and thinking that Gabriel's input could be particularly helpful.

When reviewing the video a few days later, I watched this session on my Macintosh Powerbook G4. While watching this videotape in real time, I realized the mutual focus and keen attention Gabriel afforded to the issues covered in the meeting. All of his behaviors, both verbal and non-verbal, were clear examples of micro level science demonstrations. In terms of his non-verbal participation, Gabriel's posture was upright, he leaned slightly forward and his eyes were directly focused on the speaker. These behaviors served as markers for a readiness for biological learning. These indicators get played out when Gabriel acted as one of the main speakers of the meeting. He took the initiative to comment on raised topics and also introduced new ones. For instance, Gabriel commented extensively on ways the class could run more smoothly and proposed the idea of peer tutoring. Upon close review, I saw his enactment of multiple roles during the cogenerative dialogue including being a peer adviser as he imparted important feedback on classroom practices and as a learning adviser, when he detailed how future classes could run. These suggestions are examples of meso level science learning because the emphasis is geared toward improving learning and teaching in the classroom. As I continued to replay the video at normal speed, I was taken by the facility with which he functioned in the role of student/researcher. He was fully on task during the entire meeting and seemed to enjoy the idea of changing the structures of the class to enhance student learning opportunities. Gabriel seemed to effortlessly transition between the role of student and cogenerative dialogue adviser. In one instance, Gabriel proposed the using of flash cards as a class wide learning tool and in his next turn he explained how he would use the practice as a student.

Micro-analysis of Gabriel's non-verbal and verbal actions

I reduced the speed of the video in order to perform microanalysis of non-verbal behaviors. From the video, I noticed that Gabriel rarely fidgeted and that his eyes remained focused on the speaker throughout the meeting. From multiple viewings, I realized that Gabriel's eyes not only focused directly on the speaker but that he also maintained eye-contact when he synchronously nodded in approval of Clive's or my comments. Also, he was incredibly alert and followed the changing directions of the conversation by laughing appropriately or responding verbally.

Gabriel was avidly involved in the non-verbal aspects of the meeting. In my examination of the video, I also saw how enthusiastically he verbally interacted with both Clive and me during the entire session. For instance, Gabriel made consistent eye contact with Clive and often asked his opinion. In one case, Gabriel looked at Clive and asked: "Do you think that would work?" Clive smiled, nodded, and stated, "I am with you son! Let's do what we got to do." In this interaction, Gabriel built consensus with Clive and often used the same approach when proposing ideas to me.

Gabriel was able to participate in the cogenerative dialogue meeting by successfully enacting multiple roles. For example during a number of junctures during the meeting, he became the main speaker and often directed the flow of our conversation by introducing new, but related topics. In one instance, when talking about student notes, Gabriel asked how students could more effectively utilize classroom notes. His comments started a

conversation about ways that students could become more engaged in the learning process by taking better notes. Although it would be a few weeks before the practice was institutionalized, Gabriel's idea resulted in tutoring sessions where teachers and students would meet outside of class to discuss the content of the previous day's lesson.

Lastly, Gabriel responded fluently to questions asked of him in a manner that was appropriate, timely, and relevant to the topic of conversation. For example, when I asked him what could prevent our class from learning science; Gabriel provided ideas that informed much of my planning for the course: "Mr. Lehner, you up against a lot. Ain't none of us been good in science before. And now, we have a lot of catching-up to do. It is like we have to start at the beginning." Such comments not only show Gabriel's high level of engagement but also provided entry points to discuss ways our class could approach biology instruction.

On many levels, it was clear that Gabriel was listening carefully and interacting fully during our cogenerative dialogue. Gabriel's intense focus was particularly demonstrated by his interactions. When analyzing Gabriel's talk time, I discovered that he spoke for a total of 6 of the 17 min session, or just over 1/3 of the meeting. In that time, he suggested three new classroom practices: peer tutoring, flash cards, and better use of notebooks. He also initiated new topics of conversation and took part in planning for the next class.

Many of Gabriel's actions are all clear examples of micro or meso level science enactments. For example, his attentive behavior and full engagement are micro because they do not broach biology but nonetheless positively structure the learning environment. Gabriel's classroom suggestions are meso level biology demonstrations because each proposal could potentially transform the science learning environment (see Fig. 1).

Peer tutoring

Beyond this focused attention and potentially valuable classroom feedback, Gabriel presented important details on classroom learning processes and how to put peer learning strategies into practice. Below, the transcript captures a conversation where Gabriel recommends an approach that could assist his peers in classroom learning.

> Gabriel: Yo, we have got to learn more in this class and sometimes other students buggin out stops that. If a dude is buggin, I am goin be like "chill son." Let's do this science thing.

Fig. 1 This figure captures a cogenerative dialogue

Clive: Do you think that is going to help?
Lehner: Yeah, Gabriel. What do you mean?
Gabriel: Like, if someone is not into the lesson, I could see if I could help him.
Lehner: Okay, it is a start. What do you think Clive.
Clive: My son, Gabriel knows what's up. If our classes works together and learns together, it helps all of us. It is not only me, but the whole crew learning.

As evidenced from his remarks above, Gabriel envisioned a peer executed plan to assist his fellow classmates in helping them meet academic goals. Gabriel's idea broaches the concept of collective success by thinking about achievement outside of the normal parameters of individual success. Gabriel's ideas can be thought of as a meso science learning behavior and a type of creole. He also uses the cogenerative dialogue as an opportunity to build an effective social network with Clive.

Much like the ideas that Hall (1990) outlined in his work on the dimensions of hybridized culture, Gabriel communicated his proposal couched in his lifeworld discourse. Instead of stating that the students needed to behave better, Gabriel actively engages himself in the learning process by suggesting that all students needed to be involved in the learning. He also communicates a sense of mutual responsibility for his peers. His comments indicated that his suggestion was, at least in part, an act of communalism. In this regard, such an action should be seen as a meso enactment of biology learning since his interest in the class progressed towards his peers working together. Gabriel advised both Clive and me of a possible plan of action and a clear process to achieve this goal. After Gabriel and I discussed the concept, Clive animatedly responded because his concept of communal achievement seems to coincide with Gabriel's idea. When Clive briefly reflected on the idea of collective achievement, he quickly replied, "my son, Gabriel knows what's up. If our class works together and learns together, it helps all of us. It's not only me, but the whole crew learning."

Our use of cogenerative dialogue was an important turning point for our class. In the process of conversation, we were able to jointly realize how important collective achievement was to the group. In particular, Gabriel and Clive's group orientation started to mediate my planning and thinking about our class. Prior to this conversation, I did not consider the importance that collective achievement played in his schooling but this dialogue had clearly placed that idea on my agenda. Once this type of feedback was given in cogenerative dialogue, Gabriel, Clive, and I began to discuss ways to realize this goal. Although we did not have a formal plan at the end of this meeting, we started to consider ways to inaugurate classroom guidelines which would mutually benefit all participants. Also, before this session, I was the only person planning for our lessons; after this conversation, I realized the benefits of incorporating the students into this process in order to facilitate a progression in their learning of biology.

Gabriel's comments showed his deep interest in biology even though the conversation never directly addresses science. His micro level conduct and meso level proposals were the beginning point for new instructional approaches and as a result Gabriel became a more firmly invested member in our learning community.

By creating a social space outside of the classroom, cogenerative dialogue offered a field of opportunity where Gabriel could produce micro and meso level demonstrations of science. And when he prompted me to align classroom teaching and learning, I too wanted to make strides that would focus our students on biology learning. In this setting, Gabriel was able to produce this culture because we purposefully suspended the standard classroom rules and goals. In doing so, it allowed for meaningful conversation around learning

practices. When Gabriel broached the need to employ collective measures to insure peer learning, his idea immediately garnered support from Clive. Later, when the group collective implemented a practice to follow-up on Gabriel's suggestion, possibilities for alignment were occurring in real-time by actors within the field.

Cogenerative dialogue affords a field where participants can talk across the boundaries of classroom roles and create micro and meso level roles for biology learning. By providing this social space, students and teachers were released from their traditional roles and collaboratively restructured our environment. As researchers and education administrators talk at length about classroom reform, our class quickly understood that participant applied alignment trumps any other external influence for classroom change. In our collaborative meeting, each social actor was fully engaged and was invested in finding ways to suggest and implement change. With each member fully part of this process, it took very little time to see those changes rapidly transpire. Considering all the potential problems, including a normally difficult population, alignment effortlessly became a real classroom practice in spite of the differences in race, age, and culture. Through cogenerative dialogue, we created and discussed meso learning experiences that set all participants up for possible macro science learning experiences. When Gabriel discusses ways that the class could become more involved in their science learning, he created a structure where new learning practices could be inaugurated. And although this discussion is only a meso level demonstration of biology, it nonetheless provides an opportunity for larger biological learning enactments.

Enacting ideas from cogenerative dialogue

The day following the cogenerative dialogue session, Gabriel immediately employed the ideas from our meeting. After asking for some index cards, he wrote down the definitions the class had covered in our previous meeting. Gabriel stated that he intended to commit some of the definitions to memory so that he could more fully participate in class. Below, the transcript records an interaction he had with one of his peers, Christine, as they discuss the contents of the index cards. Clive, Larry Seeram, and I are starting a classroom lesson (see Fig. 2).

Gabriel: All right Christine lets get this done.
Christine: Ready.
Gabriel: Ready? Name the three types of muscles?

Fig. 2 The enactment of cogenerative dialogue lead to instances of coteaching

Christine: Okay, I know this.
Gabriel: All right, tell then.
Christine: Don't rush me now. Well, there is skeletal. And, heart muscle. Right?
Gabriel: Yeah, you right. But is there a name for that? The heart one.
Christine: Yes, there is. It is cardiac. Cardiac muscle! And the last one is smooth.
Gabriel: All right Christine. Keep working with me and you goin be alright.

In applying his ideas from the cogenerative dialogue immediately, Gabriel helps to structure biology learning not only for him but for his classmates as well. He also takes on the new role of peer tutor as seen in the transcript above. This new role mirrors the one Gabriel spoke of during the cogenerative dialogue. He was creating an environment where science was being co-taught and co-constructed in the students' lifeworlds. Just as he had proposed during our cogenerative dialogue, Gabriel was enacting practices to align with his stated vision.

Hybridization: a process that cobbles together lifeworlds to effectively learn science

Language can be a commanding resource to scaffold biology learning for students who do not normally excel in this area. During our study when students were exposed to new information, Larry and I encouraged them to construct meaning using their abundant lifeworld capital. In doing so, many students created exciting and original learning opportunities and frequently shared their insights with fellow students. By utilizing the resonant resources possessed by our students, the class allowed for a rich variety of ways to align the biological standards to interconnect with youth culture. Although the scientific definitions were often imprecise, youth language, which is often saturated with local and hip-hop colloquialisms, became a way for students to talk around scientific meaning. It was this process of talking around biological meaning that our students were able to produce more precise measures of scientific fluency. Since a classroom is a field that is structured, a teacher can provide limit the structures that would facilitate a student's ability to produce new science learning culture.

For example, in our 8th week of class, we were 3 days into a new unit that focused on energy flow through the ecosystem. The ecosystem lesson is one where the students were having difficulty comprehending the new material. Specifically, the class started a lesson that placed living organisms into the categories of producer, consumer, and decomposer based on their role within the bionetwork. Even though Larry and I were attempting to use previously covered material to inaugurate the lesson, the students were having conceptual difficulty grasping the idea of energy transferring from a producer to a consumer.

In the transcript below, Gabriel heavily draws upon his lifeworld language structures while, in tandem, he integrates the concepts presented in the class. In the process of trying to learn biology, Gabriel produces a science creole while attempting to describe the ecosystem. Employing his present language schemas and biology vocabulary, Gabriel's development of a science creole is his own creation designed to further his understanding of the curriculum. Although linguists may formally describe his comments as pidgin because it utilizes English grammar, pronunciations, and non-standard phrases, Gabriel's speech is a science creole because he is merging his lifeworld speech with the language of high school biology. During the process of hybridization, Gabriel manufactures his own science creole created to serve his science learning needs.

Gabriel: So peep (a phrase meaning get this) it. Peep this....
Lehner: Okay, I'll "peep it."
Gabriel: Wait. I just had it. Damn....
Lehner: Go ahead.
Gabriel: Naw... I lost it. Man, I just had it. I knew exactly what I was goin say but I lost it.
Seeram: Gabriel you sure.
Gabriel: Proceed; proceed. Go ahead, it will come back to me.
Lehner: (Pause) Okay. Yesterday, we were talking about this in relation to different food chains. Remember this Hamilton-
Gabriel: Oh...oh. I got it now. If it was a little bit of grass and the cricket ate all the grass. Right? Then there would not be enough energy for the mouse and the hawk and everything would die.
Lehner: Yes, you wouldn't be able to support all the levels of the food chain.
Gabriel: (Tapping his hand on the table) Wait. What is that animal? (Pointing to the board) I don't get that!

As he produces and reproduces biology, Gabriel does not always transform classroom learning. Instead, he often misunderstands concepts or poorly rearticulates the presented classroom material. The transcript above gives evidence to the arduous, process required to manufacture the culture of science. At the end of the transcript, after attentively working in class, Gabriel taps his hand on the table and sighs, "I don't get that." Even after working hard during the class, he still needs more time and attention in order to fully understand the material. In fact, Gabriel is attempting not only to present the information to the class but also to make sense of the material himself. This interaction also shows that in spite of Gabriel's hard work, he struggles for proficiency. Yet, when allowed a field where he can attempt scientific production, Gabriel demonstrates that he can reproduce key ideas, albeit imprecisely. Gradually, Gabriel reproduces and transforms his learning practices and in doing so, he is engaged in demonstrating meso level exhibits of biology knowledge. This scenario also demonstrates the slow, at times arduous process that is entailed in moving from meso to macro enactments of biology. Rather than Gabriel perfectly articulating important curricular ideas, he instead exhibits the difficult production elements required to move to macro enactments of science.

In Gabriel's attempt to speak biology, he goes back and forth between understanding the concepts and "losing" them. In the scenario above, Gabriel employs the colloquial "So peep it. Peep this," as a way to capture the class's attention. By using this local form of interaction style, Gabriel is engaged in the process of hybridization which results in the previously mentioned science creoles. He prefaces his meso biology talk learning with speech that is both natural to him and familiar to his peers. Once he garners the attention of the class, Gabriel then has difficulty articulating his biology ideas in the same fashion that a person using two different languages may fumble when trying to merge distinct languages. The phrase "Naw... I lost it," expresses his disappointment of having understood the material, even momentarily, just to lose his conceptual understanding of it again.

Directly after this class during cogenerative dialogue, Gabriel was able to more clearly articulate the roles of consumers and producers in a food chain. I showed him the video from the class, using *i*Movie by connecting the camera to the Macintosh G4. As he watched himself engaged in the lesson, Gabriel seemed to understand the lesson better.

Gabriel: "I could say that a lot better now."
Lehner: So we were talking about food chains today. Can you tell me more about what you were learning?
Gabriel: Yeah, we were talking about food chains and how they work together. Like in the class, I was sayin that if there is not enough grass things don't go right.
Lehner: Okay, you said grass. Why are talking about grass? Does it have a role?
Gabriel: Like, grass is a producer. I was trying to say in class if there is too many consumers feigning for the same stuff things go crazy.
Lehner: Can you give me an example?
Gabriel: In class, I was saying if there was not enough grass things could bug-out. I meant like, grass eaters, if there are too many grass eaters and no grass. Well, things ain't right. And there are a whole bunch of grass eaters...mice, grasshoppers, crickets... You know, grass eaters.
Lehner: Is there a specific name for the grass eaters?
Gabriel: Herbivores... they only eat grass and stuff. Then there are omnivores... we are omnivores. And, carnivores. Like, lions are carnivores.

Once Gabriel viewed himself during the day's lesson he quickly remembered more of the biology content indicating that he was experiencing the phenomenon of cultural lag. First described by Swidler (1986), cultural lag is the delay that people experience when applying material they have previously learned. In this instance, Gabriel shows evidence during class that he is starting to understand the roles of consumers and producers yet he cannot precisely explain this material. Evidence of cultural lag is present in the transcript captured during a one-on-one conversation with him after class.

Attempting to connect his own experiences with the formal language of biology, Gabriel creates a hybrid practice as a gateway to larger understandings. By using his local speech as a way to connect to the material, Gabriel uses his lifeworld discourse as an in-field structure to facilitate his attempts at macro level biological expressions. Gabriel appropriates the new biology language and attempts to employ them immediately. This is the creolization process that is fused with hybrid practices Gabriel does appropriate the biology terms but stumbles in their use. The creolized introduction of "So peep this," and "Oh...oh. I got it now," are examples of lifeworld cultural production that he uses to aid his science learning. He is continually hybridizing his speech and practices in an attempt to gain competence. As a result, he slips into and out of proficiency as a natural process of the cultural production and reproduction cycle.

This hybridization progression should be viewed as a normal strategy nearly every student employs in order to gain competency. The primary issue is not that students hybridize practices, but that teachers sanction them. In their hybridization production cycles, students of the African Diaspora may often creolize science as a way to incorporate new material into their lifeworlds. Student will benefit when teachers officially sanction these forms of knowledge as the authentic science demonstrations they are.

Not acting white

During 5 months of research, Gabriel's fully engaged manner exposes the stereotyping around much of the current educational research on African-American underachievement in schools. Recently, Fryer (2006) captured the attention of the educational research community by widely publishing his conception of why some African-Americans perform poorly in schools. Fryer argues that many African-American students are concerned about

fully applying themselves in the classroom for fear of "acting white." While this type of hyperbole draws attention, I found that nearly all of the student/researchers conducted themselves in ways contradictory to Fryer's assertions. I strongly contest Fryer's arguments as inapplicable to the majority of students of the African Diaspora in New York City. The students involved in this study so fully connected to their homeland's cultural identity that Fryer's global assessment seems inapplicable to learning science in New York City.

For Gabriel, he clearly saw his learning identity through the lens of Panamanian culture. Even as there may be settings where Fryer's theory plays out more clearly, Gabriel seemed to prove that arduously attempting to learn science was an important aspect of his identity. Gabriel's interest in learning science seemed to increase as he was involved in this research. During an interview while we were watching a videotaped class, I asked Gabriel why he was exerting so much effort in the class. Gabriel paused and looked at the computer screen, seemingly gathering his thoughts.

> If my father saw this video, he would think I wasn't trying enough. To him, I got to learn. That's the reason I am here in this country, to do good in school. To him, and I guess me to, if you learn, you rep (represent) the country right. To learn is Panamanian. To learn is black.

In the quote above, Gabriel's comments encapsulate why he continually applied himself in the biology class. Rather than simply representing himself in the class, Gabriel was trying to embody the heritage of his ancestry. To him, his success in school was the best way to make his family proud and to represent his native country. Gabriel also expresses facets of his hybridized identity in that he appropriated the distinctive characteristics of being a diligent learner because that is an aspect of being Panamanian.

What can be learned from Gabriel?

As seen in the example of Gabriel, this research is rooted in a socio-cultural lens that illuminates differences and similarities that exist between students of the African Diaspora and African-Americans. Gabriel is an example of the thousands of students who are learning in urban schools and experiencing the cultural hybridization process. Firmly rooted in his Panamanian and urban identities, Gabriel unites his lifeworld experiences and biology learning and creating science creoles. Gabriel produces micro and meso demonstrations of biology learning that are rooted in his hybridized identities. As seen in the scenarios, Gabriel struggles to produce macro levels of science knowledge yet his involvement in micro and meso enactments seemed to connect him more fully to the learning process. As he demonstrated in cogenerative dialogue, Gabriel fully involved himself in the conceptualization and planning of an improved learning environment.

Cogenerative dialogue may improve the quality of teaching and learning in a biology class with seriously at-risk students of the African Diaspora. This research examined whether cogenerative dialogue can catalyze successful learning of biology concepts, starting with micro and meso demonstrations and leading to full-fledged macro enactments. Gabriel took part in producing many favorable learning practices which greatly helped to structure the classroom for successful outcomes. Despite his science struggles, cogenerative dialogue seemed to furnish Gabriel a fertile environment to experience new participant roles. Gabriel's involvement with cogenerative dialogue also seemed to expand his repertoire of practices to enact in the science classroom. In these expanded roles, Gabriel

accesses classroom structures differently, affording him more agency and changing the entire class's learning environment. In a Suspension Center where many of the students struggle academically, have poor attendance, and achievement records, and limited connections with adults, cogenerative dialogue can connect students more fully to the curriculum. As seen with Gabriel, cogenerative dialogue can also provide a field for the production of micro and meso level demonstrations of science knowledge.

Acknowledgments The research in this paper is supported in part by the National Science Foundation under Grant Numbers ESI-0412413 and DUE-0427570. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Boykin, A. W. (1986). The triple quandary and the schooling of Afro-American Children. In U. Neisser (Ed.), *The school achievement of minority children: New perspectives* (pp. 57–92). Hillsdale, NJ: Lawrence Erlbaum Associates.

Calabrese Barton, A. (1998). Reframing "Science for All" through the politics of poverty. *Educational Policy, 12*(5), 525–541.

Fryer, R. (2005). Acting white. Retrieved on November 30, 2006, from http://www.economics.harvard.edu/faculty/fryer/papers/aw_ednext.pdf

Guba, E., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, CA: Sage Publications.

Martin, S. (2006). Where practice and theory intersect in the chemistry classroom: Using cogenerative dialogue to identify the critical point in science education. *Cultural Studies of Science Education, 1*, 693–720.

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). *The Belmont report: Ethical principles and guidelines for the protection of human subject of biomedical and behavioral research*. Washington, DC: U.S. Government Printing Office.

Rodriguez, A. J. (1997). The dangerous discourse of invisibility: A critique of the National Research Council's National Science Education Standards. *Journal of Research in Science Teaching, 3*, 19–37.

Roth, W. -M. (in press). Bricologe, métissage, hybridity, heterogeneity, dispora: Concepts for thinking science education in the 21st century. *Cultural Studies of Science Education*.

Roth, W. -M. (2005). *Doing qualitative research: Praxis of methods*. Rotterdam. Sense Publishers.

Roth, W. -M., & Tobin, K. (2002). *At the elbows of another: Learning to teach through coteaching*. New York: Peter Lang.

Spring, J. (2004). *Deculturization and the struggle for equality: A brief history of education of dominated cultures in the United States* (4th ed.). New York: McGraw-Hill.

Swidler, A. (1986). Culture in action: Symbols and strategies. *American Sociological Review, 51*, 273–286.

Tobin, K. (2005). *Learning to teach and learn in diverse and dynamic classrooms*. Retrieved on July 12, 2005, from http://www.web.gc.cuny.edu/urbaneducation/tobin.htm

Ed Lehner is a New York City Public School Teacher and a doctoral candidate in Urban Education at the Graduate Center of City University of New York. He currently teaches and researches in Brooklyn where one area he considers is how cogenerative dialogues can be used to improve academic achievement across the curriculum. His research interests also include inclusive approaches to special needs students and science education.

Forum: Unraveling the power of creolized ontologies to strengthen science learning[1]

Sonya N. Martin, Gillian U. Bayne, and Ed Lehner

Abstract In the context of discussing Ed Lehner's (2007) article, this forum explores the use of new theoretical frameworks that have emerged in urban science education research. Situated in a conversation about urban students of color learning science, the conceptual notions of hybridized identity and creolized science can provide researchers with powerful new lenses through which to examine the relationship between student and teacher identity and the teaching and learning of science. Our purpose in exploring these issues is to raise salient questions and generate discussion focused on the use of these types of frameworks.

Keywords Hybridized identities · Creolized science · Cogenerative dialogues · Diaspora

Introduction

This forum focuses on several themes drawn from Ed's paper. Specifically, we address the importance of delving deeper in order to understand the complexity of identity in urban science education by first considering the significance of socio-historical-cultural contexts of language in science teaching and learning. Second, we examine the role of cogenerative dialogues in providing teachers and students a social space from which to consider issues related to identity.

Re-framing the language of science

Sonya: One of the things that really struck me in reading this paper was the power of words. Employing terminology from other fields, such as *diaspora*, *hybridized identities*, and *creolized science* provides the reader with a radically different perspective from which to consider some pervasive issues in urban and science education. Venturing into neighboring fields of socio-linguistics and analytical linguistics, there are some interesting parallels between the term *creolized science* as employed by Ed, where students cobble together knowledge and language from their hybridized identities of home, school, and self to make sense of science, and the development of a creole language. I intend to expand upon this in more detail in the next section, but first ask Gillian to give her read on the use of these terms as constructs for thinking about urban science education.

Gillian: What comes to mind now relates to some parallels that I am drawing from Semali and Kincheloe's work on indigenous knowledge (1999) and how it traditionally has neither been viewed in the same vein nor valued in the same ways as Western knowledge—much like certain facets, especially language, embedded within the notion of creolization. In this same work by Semali and Kincheloe, Jegede proposed that by understanding the lives of indigenous people from Africa, Asia, Latin America and Oceana, we become aware that

> ...indigenous knowledge is an everyday rationalization that rewards individuals who live in a given locality. In part, to these individuals, indigenous knowledge reflects

[1] This forum should be cited in the following form: Martin, S.N., Bayne, G.U., & Lehner, E. (2007). Forum: Unraveling the power of creolized ontologies to strengthen science learning. *Cultural Studies of Science Education*, *2*.

> the dynamic way in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organize that folk knowledge of flora and fauna, cultural beliefs, and history to enhance their lives (p. 119).

Similar to uncovering the particulars of indigenous knowledge, the intention of raising awareness and researching the various aspects of creolization and hybridized identities, especially as it relates to urban education, is to reap the benefits that ensue in encouraging the education community to use the resources that urban students bring with them to the discipline of science.

Ed: Aikenhead and Ogawa (in press) explore the topic of indigenous knowledge in relation to science learning in a future issue of Cultural Studies of Science Education. In this article, I was challenged by Aikenhead and Ogawa's position that neo-indigenous knowledge can incorporate "foreign" ideas while simultaneously remaining authentically native. The concept that natural ways of knowing can incorporate new knowledge and fully integrate these ideas into their ways of being powerfully influenced my thinking. Fully allowing students of color to naturally integrate science into their lived experiences may accelerate their learning of science. I think that science can be learned in very different ways when pathways are created that legitimate students' ways of knowing and allow for new ideas to be incorporated naturally into their lifeworlds.

Gillian: A couple of things to keep in mind as we study, read and become more aware of the complexity of epistemology include that we (a) very clearly identify what is meant by "natural ways of knowing" and, (b) liken them to, distinguish and/or differentiate them from both "innate" and/or indigenous knowledge and/or neo-indigenous knowledge. Additionally, when we speak of knowledge creation, it is imperative that we keep in mind its purpose. In considering the authenticity criteria and their relationship to the utilitarian nature of knowledge, knowledge is meant to serve all, not just a select group. So, as we consider the dialectic relationship between the individual and collective, it is imperative that we think about how the collective, not solely the "students of color" can benefit from new and alternative ways of looking at science through these lenses.

Sonya: I agree with Gillian that these words help signify a need for educators to be critically aware of the multiple, complex, rich ways of knowing about the world (and science) that their students bring to the classroom. My fear is that, much like the experiences of indigenous people, teachers and researchers will work to acknowledge the "differences" their students bring to the classroom, not to embrace these differences, but with the intent to eliminate them. The infamous slogan of the Carlisle Indian School, "Kill the Indian, save the man" (Nabokov, 1991) comes to mind when I think about how educators have historically sought to "normalize" students who come to school with language and knowledge that is not sanctioned by the mainstream. Ed's depiction of Gabriel in the following sentence: "I see a leveled progression towards fully engaging in science" was a red flag for me with regards to the terminology, creolized science. There is some undercurrent in this sentence that seems to be valuing fully engaging in science as engaging in science in the right way—the dominant White, middle class way. Ed also used the phrase "sanctioning attempts of creolization" to describe an instance in which Gabriel mixed standard science discourse with his own vernacular to explain his emerging understanding of the significance of food chains and the interdependence of life. This emphasis on converging creolized science discourse toward standard canonical science discourse prompted me to look more closely at the term creolized science in relation to the linguistic arguments around second language acquisition and decreolization.

Most famously described by David DeCamp (Schumann & Stauble, 1983), decreolization is the process by which a creole develops or converges towards the dominant official language. Bickerton (1975) introduced the notion of a linguistic continuum to further describe this process where the extent of decreolization can be tracked within a group or society by studying movement along a continuum from the basilect (the base language—such as a pidgin) to the mesolect (the creole language) and then to the acrolect (the target language). The same developmental stages exhibited during decreolization are thought by some to parallel the process of second language acquisition.

Ed: The matter of diasporic identities and hybrid practices are a crucial focus of my research. While struggling to learn biology, I saw how many of my students spoke and learned in the language of "Sabir." Roth (in press) introduces the notion of Sabir as a way that some students of color use their language skills to learn science. Historically rooted in the medieval bartering encounters between merchants who spoke different languages, Sabir is the cobbling together of many different languages and ontologies to accomplish a goal. In order to communicate these merchants needed to utilize various languages and gestures for the utilitarian purpose of trading their goods with one other. Similarly, when faced with the hegemonic structures of learning science while immersed in urban culture, our students often used metaphors, similes, and pieces of home dialect to make meaning of the biology curriculum.

Gillian: In thinking about Sonya's reference to decreolization, I am not convinced that we are to look at science acquisition and science understanding in similar lights as second language acquisition. It is because science takes on varied forms of understanding and practice in cultures that there cannot be a fixed domain as to what constitutes scientific activity and therefore, science cannot be completely and justly described as it has been—along the lines of Western science solely being the "target science." Cultures understand themselves in ways that help to identify who they are, what they want to be and where they intend to develop. Logically, it follows that epistemology standards for objectivity, rationality and truth in science and other practices must vary from culture to culture. It is to our benefit to realize that our notion of canonical science, and the language utilized to concretize ideas and concepts must be broadened to include exemplars that may be different but highly respected and utilized within varying cultures, including those that have become hybridized.

Regarding Ed's mention of "Sabir" and its utilization within urban science classrooms, I think that the notion can be broadened to not solely be considered a salient "way that some students of color use their language skills to learn science," but, a consideration that needs to be made for all those who interact in the classroom—teachers and students alike, irrespective of race or ethnicity. I can think of many specific instances when my students and I have utilized our own experiences, including dialects, metaphors, and similes, to augment the understanding and learning of content material.

Ed: The notion of "Sabir" does not view science as language acquisition. Rather, "Sabir" is a way that a student can use language to cobble together meaning as they use their home discourse to learn the science curriculum. Students' home discourses become one important resonant structure that provides resources in the science class. I think the most salient use of "Sabir" for urban science educators is to recognize that students will bring their home cultures into the classroom in very powerful and real ways. When a science teacher sanctions students to use aspects of their home culture this can provide one pathway to canonical science learning. The home discourse is an embodied resonant structure that a student always has and science teachers can uses these resources to benefit science teaching and learning, or ignore these rich sources to their own peril.

Sonya: Observed from a historical, socio-linguistic perspective, the term, *creolized science* could be construed as being a "bastardized" form of science. From a post-colonial perspective *decreolizing* science, "sanctioning" a science mesolect, is useful for those with an interest in moving a population towards the attainment of canonical science discourse. I know from my conversations with Ed that he is not a proponent of this development. I think it is important to emphasize that Ed's research suggests that by identifying points of hybridization (the micro, meso, and macro levels of science engagement), the points where home and school science intersect, teachers and students can begin to recognize the significance and validity of students' science understanding in their own words. Acknowledging these differing levels of science engagement allows students and teachers to celebrate individual diasporic identities in positive ways, without requiring students' understandings of science concepts to be compared with the canon of "real" science.

Ed: As a researcher in this area, I think it is important to have specific language to explicate the concepts being studied. For example, the sophisticated use of creolization and hybridization details what many African-Americans and students of the African Diaspora are experiencing in science classrooms. During our research, the enactment of standards based biology took some time. The process was hastened because the class created structures that legitimize lived world experiences, which catalyzed the students' understandings of those concepts.

In particular, Gabriel's understanding of biology continued to grow by affording him multiple opportunities to produce biology knowledge. Much of his in class speech was biology-like and over time became increasingly scientific. He continued to hybridize his practices by making use of the biology curriculum. He first performed low level hybridized forms, leading to meso level, and eventually, standard discourse. This notion of affording latitude in accessing academic work aligns well with other researchers' views on utilizing student skills. For example, Carter stresses how important it is to both sanction and build from student strengths. Building on Pierre Bourdieu's cultural capital, Carter (2003) maintains that dominant and non-dominant forms of such capital exist. Specifically, Carter advances that students of color possess rich, non-dominant forms of cultural capital, which they use successfully in their lived world experiences. I mention Carter's work because there is a growing body of literature emerging that highlights how significant results can be attained when starting with urban students' skills.

Sonya: In fact, a great deal of research in the field of applied linguistics recognizes the positive effect teachers can have on student learning by legitimizing creole, pidgin and minority dialects in the classroom. Some integrative approaches that have proven especially effective in increasing student participation and achievement are (1) using music or literature from the students' mesolect in class, (2) encouraging students to speak and write in their mesolect, (3) teaching some basic socio-linguistics to help students recognize the legitimacy and value of their mesolect, and (4) explicitly examining the linguistic and pragmatic differences between creole or minority dialects and the standard language (Siegel, 2002, p. 16). Ed's introduction of hip-hop and rap music, as well as student-driven metaphors, as methods for supporting student discourse and development of science concepts, are good examples of how legitimizing creolized science can help increase student understanding of science concepts as well as improving participation and achievement.

Cogenerative dialogues: a tool for re-conceptualizing differences and similarities

Sonya: Reading this paper, I found myself agreeing with Ed that the majority of educational research tends to oversimplify complex, multi-faceted issues, such as differences in achievement between students of different races. The tendency for students to be lumped into narrow categories such as Black, White, Asian, Latino/a, and Native American no doubt arises in part from the need for researchers to generalize their findings in an effort to make their research applicable or transferable to a larger audience. This research poignantly demonstrates the ways in which this practice places students and teachers at a disadvantage in the classroom. Ed's use of the concept *diaspora* as a framework from which to disentangle his students' individual experiences and identities as related to, but separate from the monolithic label of African-American is particularly salient when considering what is meant by developing a culturally relevant curriculum from which to teach *these* students science. Using cogenerative dialogue as a social space, in which students could interact with Ed outside of the traditional classroom setting, provided Gabriel and his peers a forum for exploring their individual and collective identities as members both of different ethnic groups and a shared race. These findings add to and enhance a growing body of work recognizing cogenerative dialogues as a powerful tool for helping teachers and students engage in meaningful conversations around sensitive and complex issues such as race, ethnicity and gender in a variety of school settings. I invite Gillian to comment on the use of cogenerative dialogues as a tool for helping students and teachers address these issues.

Gillian: It is very exciting to imagine students and their teachers broaching, discussing and helping one another to make meaning of important issues related to the teaching and learning of science in a world of increasing globalization, especially as these issues often times are either directly or indirectly related to concerns involving ethnicity and race. Given the multifaceted nature of teaching and learning within an urban setting and the diversity of students it encompasses, it is imperative that the pedagogy, which teachers employ, is grounded in a social, cultural and educational vision of justice and equality. Valuing varied ontologies, especially *creolized* ones, may never have been more urgent. By studying, building upon, and utilizing socio-cultural, historical and psychological theoretical lenses, the ability for teachers and researchers to consider and appropriately address the effects of the rapidly increasing complexities that arise within urban science education becomes more feasible.

Through cogenerative dialogues, Ed has provided insightful examples in his paper, offering glimpses into how opportunities for learning about our students and the capital they bring to the classroom are discernable and useful in shaping their attitudes, interests and participation in science. Within the field of cogenerative dialogues, it is important to witness how these very "at risk" urban students, who have been alienated in the past by canonical science, have forged social bonds, developed expanded teaching and learning roles, and enacted new forms of culture to access structures which enable them to contribute to their own learning and, equally important, the learning of others in substantive ways.

Ed: Working from the point that Gillian just raised, too many teachers view the learning of science as something that "happens to" students, rather than thinking about science instruction as being co-constructed and co-implemented in the spirit of a partnership. In my research, the students and I have focused on ways we can collaborate together and, as a

result, often the cogenerative dialogue returns to a core idea that was emphasized during our collaboration: how we can improve the teaching and learning of science.

Gillian: Extremely interesting to me is the population of students with which Ed interacts. The rich descriptions of how students identify the hybridized nature of their Caribbean linguistic, racial and ethnic selves can be daunting to an "outsider." A commonly held view of West Indians is that they have easily assimilated into the American way of life, and have prospered readily. Waters, in her book *Black Identities* (1999), chronicles a different reality for many, especially those who are second generation Americans. We hear an echoing of this reality in the stories shared by the students in Ed's research. In addition to having their personal challenges that place them in an "at risk" category, they are frequently viewed from a deficit perspective and often times experience similar challenges in their various lifeworlds as other Black and African-American students do because of negative stereotyping.

An important point raised by Waters revolves around how race classification has influenced those from the Caribbean, especially the working middle class, of mixed racial and ethnic ancestries. So much of this classification, its internalization and, perhaps racialization has to do with the recognition, or lack thereof, of the importance assigned to social status. As a Black woman whose roots are from the Caribbean, my concern is that as we consider the racial and ethnic complexities of our students, we do not lose sight of the fact that social status and class are important factors likely to have strong implications for how they perceive themselves, and ultimately how social life unfolds within the science classroom.

Ed: Gillian's point that builds on the work of Waters is important. For many students from the Caribbean, the process of assimilation into American culture can be difficult. It is a complex process where first or second generation students seem to feel the pressures to assimilate into urban, often African-American, culture while simultaneously being required to learn large-scale elements of mainstream, often White, macro culture. The different ontologies represented in today's urban classroom provide many entry points into learning science, but often, as Sonya pointed out, these differences are minimized or entirely overlooked.

Making meaning of identity to challenge negative stereotypes

Sonya: The benefits of recognizing and celebrating the differences between students of differing races and ethnicities is obvious in terms of making students feel valued as individuals. In addition, it is clear that creating spaces for sharing across the social borders existing between teachers and their students expands teaching and learning opportunities. However, the necessity to engage in conversation with students about these issues may not be obvious for teachers or students who do not recognize differences across seeming homogeneity.

Gillian: Urban settings are teeming with new immigrants and minorities. Sonya, could you share some of your experiences from Philadelphia as they relate to some of the challenges and concerns around immigrant students and this seeming homogeneity?

Sonya: While visiting a large inner-city school in south Philadelphia, I had an opportunity to speak with some students in a chemistry class who had been placed in a small group by their teacher so they could "help one another." The students explained to me that this particular teacher always placed the Asian students together in one group so they could

"explain everything to one another in their own language." The problem with this assumption was that the Vietnamese, Cambodian, and Indonesian students the teacher had lumped together had only English as a common language. One of the students lamented that being with other non-native English speakers placed them all at a disadvantage in chemistry class. And even though these students had shared this concern with the teacher, she persisted in her belief that they "worked better together than they would with other students in the class." A fourth Asian student, who identified herself as Chinese-American, described her experiences of teachers placing her in groups with new immigrant students in order to "help" them, which, she said she was unable to do since her family has been in the United States for generations, and she and her family only speak English! When I share this story with other teachers and teacher educators, their common response is that this woman is "just racist" and that very little could be done to challenge her beliefs. I imagine, however, that this woman's actions come more from her ignorance about the differences between her students. Upon interviewing this teacher, who identified herself as African-American, she admitted she did not know that "they weren't all Chinese." Even though she knew that they were from different countries, she was not really sure what that meant and she had never thought to ask. She said she was "just trying to teach them some chemistry" and that it was her policy "not to have conversations with her students about their personal lives."

I imagine similar scenarios such as these are played out everyday all around the country in both large urban schools and suburban and rural settings, anywhere there are new immigrants or minorities, such as the Chinese-American student who is perceived as a "perpetual foreigner" (Wu, 2002) no matter how long she and her family have called this country "home." The students in question could have just as easily been Latino students from Ecuador and Mexico in a rural school in Georgia or, like in northeast Philadelphia, recent Ukrainian or Polish immigrants. The issue in this vignette was that this teacher did not know her students and she made erroneous assumptions based on what little she did know. Ed's research demonstrates how powerful cogenerative dialogues can be in providing teachers and students a forum for learning about one another, enabling them to expand learning opportunities based on their increased awareness about the differences and similarities between them.

Ed: Sonya raised the point of Asian-Americans being perceived as perpetual foreigners in North America and I think a similar phenomenon is occurring for students of the African Diaspora. A significant portion of the educational literature frames African-Americans as not fully engaging in the curriculum or lacking science-based interest. In my paper, I mentioned Fryer (2005) whose work adds to the established "acting White" literature. However, in my research in urban classrooms, I see little empirical evidence to support Fryer's claims that African-American students do not want to learn for fear of acting White. In fact, Fryer's macro level claims seem to align with negative stereotyping and undervaluing of these students' skills. Often, students come to the science classroom excited to learn but are met with pedagogy that is not inquiry-based and frequently teachers do little to align the curriculum with their lifeworld experiences.

Gillian: We can see that the idea of hybridized identities becomes increasingly complex as it relates especially to students of the African Diaspora, since they do tend to be racialized in a negative manner. This is the case with a student from my class. Within her peer group and among her teachers, Emma Jean is known as a quiet, reserved and hard working student. She has not been typecast as "acting White" even though she admits to being racialized both in negative and positive ways because of her mixed racial, ethnic and linguistic makeup. Emma Jean's mother is Malaysian, her father is African-American and

her stepfather is Puerto Rican. She takes pride in being fluent in English, Cantonese and Spanish. "Usually when people see me, they think that I'm ghetto, loud and have an attitude. But, when they find out that I am part Asian, they automatically assume that I'm good at math, which I am not."

Sonya: Ed's comments concerning negative stereotyping and their influence on the development of curriculum that neither speaks to students' interests, or worse, alienates or devalues their ways of knowing, underscores the importance of teachers and students learning about one another through cogenerative dialogues. Gillian's example reinforces how cogenerative dialogues can empower students by providing opportunities to examine social, cultural and racial issues with others. Emma Jean's recognition that, regardless of how she self-identifies, interactions with other people are largely dependent upon how she is identified by them can be empowering *if* she is aware of it. Armed with this knowledge, Emma Jean may be less likely to internalize negative interactions and it may inform her decisions about how she chooses to interact with others. Cogenerative dialogues can be transformative in that individuals can be afforded the opportunity to enact practices with intent and directed agency. This critical awareness can help to diminish determinism and reduce possibilities for social reproduction.

Hybridized identity

Sonya: Using his students' experiences as examples, Ed demonstrates the significance of recognizing the unique ways in which his students differ from him *and* one another in an effort to help his students engage in science learning from their individual perspectives. I feel that one of the important contributions Ed's paper makes to the educational community is to challenge teachers and researchers to recognize, as Roth (in press) wrote in a paper discussing hybridized identities, that "it is the singularity that makes students different rather than their difference that makes them singular." Ed's research underlines how true this is for all students, regardless of their individual racial identities or shared cultural identities. The concepts of hybridization and diaspora are critical tools for thinking about individual differences in ways that can be positive.

I think that by employing Roth's (in press) notion of hybridized identity, Ed demonstrates how teachers can theorize all students who are in the process of learning science as being in a diaspora. Roth suggests that for many students, science is experienced as foreign to the culture they experience in their homes or even other subjects in school. The concepts of diaspora and hybridized identity have broader implications for science education. Encouraging teachers to view students as singular in their experience of making sense of science would necessitate a mental shift away from thinking about student ability and performance as tied to racial or ethnic categories. Theorizing science learning in this way provides teachers with frameworks for critically re-evaluating their beliefs about what it means to *know* and *do* science, hopefully in ways that begin to diminish current practices that marginalize minority students' science talk and learning.

Gillian: As I think about hybridized racial and ethnic identities, I think that it is extremely important to keep in mind the role that social class and status of students and their families play in constructing notions of self and the value that is placed on education. From my experience, there are many variables and obstacles that mediate perspectives on education, both in one's native land and in America, including access to and involvement in education. Another consideration is that there are those of the African Diaspora,

especially those who have come from exposures of neo-colonialism, who would argue that their educational experiences, as they relate to math and science are founded upon standards that are *more* rigorous than those that are encountered in American curriculum. Hence, as Ed speaks of the importance of respecting, researching and learning about these oftentimes marginalized youth and their hybridized cultures, yet identifying "...how students' homeland cultures can assist in their science learning" (as encountered through the American education system) could be construed as being of little significance to some.

These ideas are critical aspects of our work and demand serious consideration if we are meaningfully to make inroads into valuing the science experiences and knowledge that students bring to the table. We must recognize the complexity of our students and the knowledge they bring to science, especially as they relate to indigenous and creolized scientific knowledge along with what may be considered "science-like" knowledge and practices by the hegemonic majority. In Hall's (1990) work on cultural identity and diaspora, he proposes that while cultural identity often involves a shared history and ancestry, it "is not as transparent or unproblematic as we think... [W]e should think of identity as a 'production' which is never complete, always in process and always constituted within, not outside, representation" (p. 222). Education is not an objective structure, but a constructed one—one that ought to be in a state of *dynamic equilibrium*, always endeavoring to become increasingly inclusive of, and shaped by, the complexities of who we all are, irrespective of race, class, national origin and religious belief.

Using cogenerative dialogues to construct/ de-construct identity

Sonya: This discussion reminds me that, in addition to their racial or ethnic identities, students' identities as science learners are also at stake. It is widely reported that minority students under perform in school and unless teachers are cognizant of the lenses through which they interpret these findings, they may negatively associate student performance with ability. From there it is only a short leap to imagine teachers (and students) associating poor performance with race or ethnicity, resulting in the negative stereotyping to which Ed and Gillian refer. This is why Ed's emerging research on hybridized identities appeals to me as a more constructive and inclusive framework for thinking about the ways in which race, ethnicity, and teaching/learning intersect in the science classroom.

Gillian: In the domain of teaching and learning, as in other areas of life, it is not uncommon for assumptions to be made and stereotypes to be upheld around teaching and learning as they relate to an individual's phenotype. What someone looks like racially can be very much misaligned with how she identifies herself both racially and ethnically. Through cogenerative dialogues, teachers have exciting opportunities, which afford new ways to learn about the many different aspects of a student's life. Not only can teachers move forward in creating appropriate science learning environments, but also through these meaningful and constructive talks with students, teachers are provided opportunities to more appropriately learn about hybridized identities.

Ed: Gillian's observation about typecasting students cannot be overstated. In my research, I need to suspend any initial perception of a student because notions of the urban archetype can become too powerful and may influence my global understanding of a particular student. While attempting to postpone these preliminary judgments, I consciously try to engage students in conversation, but also, when some time has elapsed, into the research and cogenerative dialogue. By providing a structure that includes students in

the teaching and learning of science, and its research, students are provided more roles than the traditional "learning" function. Involving students in research also affords me the opportunity to experience the multi-dimensionality of strengths and skills that are brought to the classroom.

Gillian: I am very concerned about certain aspects of what has just been said, yet appreciative that Ed provides us with an opportunity to share in an aspect of the power and beauty of cogenerative dialogues. Ed's comments pertaining to his struggles with trying not to typecast urban students, his need to "suspend any initial perception of a student" and his attempts to engage students in conversation while he "postpone[s] these preliminary judgments" serve as prime examples of how that which he may not have been aware of—namely his prejudgments about his students—are now being exposed and wrestled with in an active, conscious way. It is because of engaging in the critical conversations that cogenerative dialogues afford, that he and his students are better able to understand boundaries that have existed between them due to misalignments around, race, ethnicity, age and social class differentials. They are creating new culture which will get reproduced and ultimately transform the fields within which fluid science teaching and learning occur. Becoming aware of who we are as individuals and how we impact the production and utilization of knowledge are all at the core of generating individual and collective critical ontologies.

Sonya: Ed reiterates the critical importance of cogenerative dialogues in helping teachers better understand their students, but I can imagine teachers being overwhelmed by the enormity of this issue. Take for example the challenge facing the chemistry teacher I introduced earlier. In subsequent conversations I had with the four Asian students from her class, I learned that one student, named Dieu, considered himself racially to be Vietnamese—meaning he was born in Vietnam, spoke Vietnamese, and self-identified as Vietnamese. However, he and his family simultaneously identified as ethnically Chinese. At home his family spoke a dialect and they followed religious customs that were distinctly Chinese. Dieu and his family were considered ethnic minorities in Vietnam even though they had lived in Vietnam for generations! Both the Cambodian and Indonesian students shared similar stories, identifying as ethnic minorities in their countries of origin. These experiences make salient the complexities that underlie making sense of identity in multi-ethnic, racially diverse urban schools, especially when we consider that these are only three of about 120 students this chemistry teacher interacts with each day. But when I think about the struggles these students face just trying to "fit in" to the social life in their inner-city high school—and on top of that, learn chemistry, I feel teachers have to be doing more than "just teaching chemistry." The benefits arising from this teacher recognizing and understanding just these three as individuals can mediate how this teacher thinks about all of her students.

Gillian: Invariably, when we do take a close look at our students' identities, it is likely that there are more hybridized identities than what meets the eye. Sonya's description of Dieu is a perfect example of how within cogenerative dialogues the perspectives, experiences and schema of others become resources for reflection and for making meaning of others' lifeworlds. An immediate understanding of social life and patterned actions in the science classroom and elsewhere are essential for understanding our teachers and students. Just recently I wanted to get a better idea of learning styles and strategies with some of the students of color in my own ninth grade biochemistry class. In a cogenerative dialogue, we spoke about informal and formal exposures to science, family influence in constructing meaning around science content, and students' science identities as they relate to their different religious, racial, and ethnic backgrounds.

I was very curious about the latter, especially as it related to one female student, Bonnie, a native of Guyana, who is racialized along East Indian lines. Being racialized commonly involves placing someone into a racial and/or ethnic category that is based primarily on her outward appearance and/or presentation. Bonnie shared that others often identified her as East Indian. However, when given an opportunity to describe herself, Bonnie identified her racial heritage as a combination of Black, White, Portuguese, East Indian and Amerindian (native Indians of Guyana). More importantly, Bonnie shared that her religious affiliation with the Muslim faith was what she felt was the most salient aspect of her identity. When asked about how she thinks others view her as it relates to race and ethnicity, Bonnie admits that not only does she not know what others think of her, she does not use race and ethnicity as means of identifying herself because, these aspects of self are very complex and not easily reduced into component parts.

Ed: Gillian's comments about Bonnie remind me of my experiences with a student named Hamilton who is a second generation Dominican-American. As I detailed in the paper, Hamilton compared/described himself based on his differences compared to the larger African-American community. The complex ways that he understood his dual identity as a Latino and as a Black man speaks to the complexity in considering both ethnicity and race. He combined the distinctive elements usually attributed to ethnicity and race into one hybridized identity.

Gillian: My parents emigrated from Guyana to New York. It was through cogenerative dialogues that I discovered that Bonnie and I share many of the same racial and ethnic affiliations. This conversation provided some unexpected information, as well as a new lens from which to theorize the kinship I had always felt with Bonnie. Just as in the case of misaligned culture, people experience culturally aligned social life at both conscious and unconscious levels. Closer examination, using micro- and meso level video analyses, of our interactions in the classroom and in cogenerative dialogues revealed patterns of alignment in our ways of being that may have served us both well within the teaching and learning arena. Although we were not aware of this alignment prior to our conversations, the possibility that it may have played a role in the fluidity of our exchanges and consequently the learning of science has been substantiated.

Often times not only is the classroom comprised of a heterogeneous group of students, but the teacher is commonly of a different racial and/or ethnic group, as well as from a different socioeconomic level. In fact, it is much less common that the racial and ethnic identities of the teacher and student in the urban science class setting coincide. This is one reason why cogenerative dialogue research is so promising. Although Ed is quite different in many regards from his students, cogenerative dialogues provided him with a means of becoming more familiar with his students racial and ethnic backgrounds, as well as elements of youth culture. These conversations provide a forum for him to express interest in learning more about his students as learners and leaders. It is very likely that he has had to work hard at accruing social capital with the group and part of that process has involved affording opportunities for these students to elaborate on how they construct their individual identities, as was the case with Gabriel, Hamilton and others. These are extremely important steps in being able to gain his students' respect and trust.

Ed: Building on an issue Gillian raised and in relation to the vignette Sonya shared, I think it is paramount that ethnographic researchers describe in detail the populations with whom we are working. Often this is not done. And even when descriptions are presented, the descriptions of the participants are incomplete or inaccurate. For example, much of the science education research describes African-Americans in opaque ways which seemingly employ a universal grouping. In New York City, there are well over a million people who

represent the countries of the African Diaspora, and this figure does not include African-Americans. In a recent paper I read, African-Americans were described as underprivileged, performing poorly in science, and underachieving across the curriculum. These deficit descriptions are not only a disservice to the students studied, but also do little to elucidate readers' understandings of the setting.

By employing radical doubt, I challenge the notion that African-American students are under-skilled and ill-prepared for science instruction and in doing so, I challenge researchers to consider the complexity of social life as played out in the classroom. Placing these concepts in dialectical opposition to each other, Roth (2005) uses a Sheffer stroke ("|") to capture the recursive association between what seems like opposing ideas. In doing so, Roth challenges researchers to think about what skills are present and can be used to augment science teaching and learning, rather than focusing on student deficits.

Adalist-Erin and Mustin (2006) argue that students who live in poverty, attend underperforming schools, and reside in violent neighborhoods are more likely to be at-risk of quitting school or be imprisoned. When I employ radical doubt to the notion that my students are "at-risk," the process of thinking about the problems they face and their resonant skills forces me to acknowledge how many life skills my students possess. Many of my students are at-risk of dropping out of high school or being incarcerated in New York State's expanding prison system. Simultaneously many of these students are highly skilled, competent and intelligent. To capture this complexity, I use the Sheffer stroke to denote the dialectical relationship between Risk Resilience. For example, many of the students play crucial roles in their home lives where some work a part-time job and others take care of siblings to help their family. Other students have very high verbal skills and use these abilities to build strong relationships with their peers and important members in their communities. Still others have been exposed to life difficulties, such as the loss of a parent, living in a high-crime neighborhood, or circumnavigating gang activity. These experiences have equipped them with maturity beyond their chronological years. The fact that these students live in New York City embodies the idea of Risk Resilience where the social setting has placed them "at risk," but their surroundings have equipped them with many important skills.

Acknowledgments The research in this paper is supported in part by the National Science Foundation under Grant Numbers ESI-0412413 and DUE-0427570. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Adalist-Erin, A., & Mustin, J. (2006). *Risk and protection*. Retrieved on November 30, 2006, from http://www.nationalserviceresources.org/filemanager/download/children_of_prisoners/CPL104-RiskandProtection.pdf

Aikenhead, G., & Ogawa, M. (in press). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*.

Bickerton, D. (1975). *Dynamics of a creole system*. New York: Cambridge University Press.

Carter, P. (2003). "Black" cultural capital, status positioning and schooling conflicts for low-income, African-American youth. *Social Problems, 50*, 136–155.

Fryer, R. (2005). *Acting white*. Retrieved on November 30, 2006, from http://www.economics.harvard.edu/faculty/fryer/papers/aw_ednext.pdf

Hall, S. (1990). Cultural identity and diaspora. In J. Rutherford (Ed.), *Identity: Community, culture, difference* (pp. 222–237). London: Lawrence & Wishart.

Nabokov, P. (1991). Native American testimony: A chronicle of Indian-White relations from prophecy to present, 1492–1992. New York: Penguin Books.
Roth, W. -M. (in press). Identity as dialectic: Agency and participation as resources and fields in the emergence of hybridized identities that acknowledge science and home culture. In A. Rodriguez (Ed.), *The multiple faces of agency*. The Netherlands: Sense Publishers.
Roth, W. -M. (in press). Bricologe, métissage, hybridity, heterogeneity, diaspora: Concepts for thinking science education in the 21st century. *Cultural Studies of Science Education*.
Roth, W. -M. (2005). *Doing qualitative research: Praxis of method*. The Netherlands: Sense Publishers.
Schumann, J. H., & Stauble, A. -M. (1983). A discussion of second language acquisition and decreolization. In R. W. Andersen (Ed.), *Pidginization and Creolization as language acquisition* (pp. 260–274). Rowley, MA: Newbury House Publishers, Inc.
Siegel, J. (2002). Applied Creolistics in the 21st century. In G. Gilbert (Ed.), *Pidgin and creole linguistics in the twenty-first century* (pp. 7–48). New York: Peter Lang.
Semali, L., & Kincheloe, J., (1999). *What is indigenous knowledge? Voices from the academy*. New York: Falmer Press.
Waters, M. (1999). Black identities: West Indian immigrant dreams and American realities. Boston, MA: Harvard University Press.
Wu, F. H. (2002). Yellow: Race in America beyond black and white. New York: Basic Books.

Sonya Martin is an assistant professor in science education at the Drexel University School of Education. Having completed a master's degree in both elementary education and secondary chemistry education at the University of Pennsylvania, she has taught science at many levels within the school district of Philadelphia. She received her Ph.D. from Curtin University of Technology in Australia. Currently, her research focuses the use of cogenerative dialogues and video analysis as tools for introducing University faculty, and both in-service and pre-service teachers to effective means of examining classroom teaching and learning practices.

Gillian Bayne is an assistant professor in science education at Lehman College, City University of New York. She has extensive teaching experience in secondary science education and has taught in the New York City Public Schools system for over ten years. Currently, her research is focused on the utilization of cogenerative dialogues to improve science teaching and learning.

Ed Lehner is a New York City Public School Teacher and a doctoral candidate in Urban Education at the Graduate Center of City University of New York. He currently teaches and researches in Brooklyn where one area he considers is how cogenerative dialogue can be used to improve academic achievement across the curriculum. His research interests also include inclusive approaches to special needs students and science education.