"I Am Science and the World Is Mine": Embodied Practices as Resources for Empowerment

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Those who are most marginalized, both culturally and economically, in society are concentrated in the nation’s largest urban centers and have the least opportunities to be successful in school science or to pursue higher education and career trajectories in science, mathematics, or engineering. This article shares the results of a study in which African American economically disadvantaged high school students living in Philadelphia were hired as student researchers and had the opportunity to develop a curriculum enhancer – a movie entitled Sound in the City. The findings reveal that the students’ capacity to act, or their sense of agency, expanded both through the process of making the movie and with the final movie product. During the production of the movie, the youth accessed multiple resources (both physical and human) to represent abstract physics facts in contextualized ways. Specifically, this article illuminates how they drew upon embodied practices that included rhythm, verbal fluency, and high energy in creating and filming the movie segments, as well as behind the scenes as they worked to understand the physics content. This study urges the science education community to consider how students’ embodied practices can connect them to science in empowering ways that expand their capacity for action in multiple spaces.

Kareem: Yeah, but then again I don't like finding the science in stuff. I don't find it amusing.
Rowhea: You don’t find it amusing? Oh boy. Cuz [because] of what?
Kareem: I mean cuz the definition that I be givin’ em about the science that’s in me [emphasis added] is not what they want. ...
Rowhea: What were you saying as your answer? ...
Kareem: Science is everything and I’m science. The world and everything in it is science. And I’m science so the world is mine.... It’s L.L. Cool J.
Rowhea: Really? Does he say science?
Kareem: No, he say, he say, “... Hip-hop the streets and I’m hip-hop, so the streets is mine.”

Science as a Means for Empowerment

There is much to be learned in considering the comparison of “hip hop and the streets” with “science and the world” in the above rap lyric creation by Kareem, an African American male student researcher from an economically disadvantaged inner city neighborhood in Philadelphia. For many youth like Kareem, ownership of the streets refers to one’s ability to hold a high level of respect or status in one’s neighborhood (Anderson, 1999). Hip hop represents a common medium through which some youth build such status with peers; for example, freestyling or spontaneously performing rap on the neighborhood streets can build social relationships that provide access to important human or physical resources (Elmesky, 2003). Although in the original rap the tool for empowerment on the streets is hip hop, in Kareem’s version, science is the instrument and the world is the entity to be conquered and within which ownership and status will be achieved. In his own way, Kareem is expressing an understanding that success in science can open opportunities for him; namely, science is a means for personal empowerment.

Empowering for Whom?

Science, in the current state of affairs, is empowering – predominantly for those students who are White, middle to upper class, enculturated into Eurocentric value systems and successful in showing evidence of learning a predetermined body of scientific knowledge (through standardized assessment measures). Their reward is metaphorically “the world” for they have access to multiple resources in society, including advanced coursework, higher education opportunities, and prestigious careers. In contrast, those who are most marginalized, both culturally and economically in society,
experience science classrooms as sites for struggle and repeated failure.

Unfortunately, school science perpetuates social inequities, intergenerational poverty, and the social and economic isolation of marginalized populations. When students like Kareem consciously or unconsciously bring their knowledge, values, and interests into the unfolding science curriculum, they are shut down, undermined or ignored. Instinctive manners of interacting, communicating, moving, and simply being often position them in an unaligned fashion with school science, and they experience "symbolic violence" (Bourdieu, 1992). Thus, their ability to access and appropriate science as a tool for empowerment is stunted since, as they participate in school science, their ways of being are not perceived as useful. Success in school science, as defined by National Science Education Standards (National Research Council, 1996) and associated assessment and accountability measures, often entails embodying those ways of knowing and acting that are associated with being White, middle class, and male. That is, scientific literacy and science education have been situated within a rigid culture of science that values the individual over the collective, the abstract over the contextualized, and the objective over the emotional (Roth & Barton, 2004). It also proclaims authority on what constitutes important knowledge. Therefore, unless students learn to communicate scientific literacy in ways that are recognized and acknowledged in the dominant society, science as a field remains inaccessible by the majority of marginalized populations, most of whom are situated in the nation's largest urban centers.

This paper provides findings that illuminate the importance of providing marginalized students, attending inner city neighborhood schools, with learning opportunities that are expansive and embracing of their embodied resources. Through the descriptive account and analysis of a movie segment and an associated "behind the stage" vignette from a student researcher-produced (40-minute) movie entitled, Sound in the City, I share images of how urban youth can connect with a traditionally distant and alienating science culture in empowering and contextualized ways.

**Contextualizing the Study**

This study involved my work with five African American students from economically disadvantaged backgrounds attending an inner city neighborhood school in Philadelphia. Although my work with them extended over their high school experience, I focus here on the first summer research session in which May, Ivory, Shakeem, Randy, and Kareem were employed as student researchers on a study funded by the National Science Foundation (Elmesky & Tobin, 2005). An overarching objective of the study, also known as Discovering Urban Science (DUS), was to gain a deep understanding of how to improve the teaching and learning of urban youth—youth who are culturally and economically marginalized within the nation’s largest inner city centers (in this case, Philadelphia). The student researchers participated in a variety of roles (e.g., learners, researchers, teacher educators, and curriculum developers) across social fields, including the workplace, neighborhood, home, and science classroom. Here I focus upon their enactment of curriculum development roles and illuminate the resources they accessed and utilized in producing the Sound in the City movie.

**Expanded Agency: Resources and Empowerment**

Resources can be empowering. The ability to exercise agency or to act in different spaces in the world is shaped, in part, by the ways in which one accesses and appropriates resources (both embodied and external) to meet one's goals (Sewell, 1992). Thus, significant to a paper focused upon science and empowerment is a discussion of the ways in which student researchers accessed and utilized new or existing resources to produce the sound movie.

The range of resources the researchers utilized during the creation of their movie spanned two major categories, material and human. Material tools included computers with Internet access, physical science books, university lab facilities, simple supplies for representation of learning (poster board, markers, and music CDs) and a video editing station, consisting of a computer with iMovie software, a VCR and monitor, and an analog-digital converter. After video recording the student researchers' representations of the physical science concepts, they utilized the video editing setup to import and edit the video clips that they wished to incorporate into the movie. When most of the video clips had been imported, edited, and sequentially arranged, the final phase of the movie production involved adding transitions, appropriating sound effects, and inserting text.

In addition to the material resources accessible to the youth, human resources were consistently utilized throughout the movie production process. Human resources existed in the form of social relationships and cultural dispositions and were also discursive in nature.
For the remainder of this paper, the findings will center upon the students' use of embodied resources to develop alternative, contextually embedded images and examples associated with abstract scientific facts. Embodied resources can be understood as ways of being (both conscious and unconscious) that may include specific knowledge, values, skills, morals, aspirations, rituals, beliefs, goals or interests as well as manners of interacting, communicating or moving. In accessing and utilizing their embodied practices (in new ways) to relate to science, the student researchers were being agentic; their capacity for action had expanded.

**Content Versus Process: Which Is More Empowering?**

The science content included in the movie was determined by the student researchers' identification of major concepts related to sound, such as wavelength, amplitude, and the physical interpretation of frequency as pitch. Although some would argue that there is little significance in studying student practices associated with such basic science constructs, the analysis of segments of the movie and of the behind-the-scenes work that occurred in designing, producing, and editing the movie footage illustrates that it was not the specific science content but rather the process (and specifically the resources accessed during the process) that was empowering. That is, although the science facts initially driving the production of the sound movie were abstract and typical of the very science culture that alienates marginalized students, the nature of the movie project encouraged the students to contextualize discussions of sound facts within their own physical and social worlds and to draw upon their own embodied resources to animate and relate to the physical science constructs. Through skits, rap, dance, posters, and simple props that featured symbols and practices from their experiences in contexts outside of school, a distant, irrelevant culture of science became theirs - alive, humorous, emotional and deeply connected to experiences typical of their lifeworlds. Through a study of their practices as student researchers/curriculum developers, this study challenges us to consider what happens when urban youth become science - that is, what happens when youth are allowed to approach scientific bodies of information in collective, contextualized and embodied ways?

**Design of the Study**

The findings presented in this paper emerged from a longitudinal critical ethnography (e.g., Barton, 2001; Pizarro, 1998) concerned with combating social inequities through building deep understandings of how science education can become a more empowering and transformative experience for urban youth. Thus, while the science-related activities discussed in this article take place in a university setting where student researchers were employed to develop curriculum materials like the sound movie, the implications for the agency they exercised can extend longitudinally into their lifeworlds.

**Data Sources**

As student researchers, the youth participated in a variety of activities associated with both learning science and conducting ethnographic research in and out of school for 10 weeks in the summers of 2001-2003 at the University of Pennsylvania. Initially, the student researchers were primarily involved in data production and collection; during the subsequent summers, the youth were more intimately involved in the interpretation and analysis processes. They were exposed to sociocultural theoretical frameworks and taught how to perform micro-video editing analyses of their science classrooms, utilizing software such as iMovie. Their work also included journaling, writing and performing rap connected to science, life, and theory, conducting Internet research, acting as ethnographers, and designing, conducting, and transcribing interviews. The summer research activities were video and audio taped, as were the ninth- and tenth-grade science classes of the student researchers, to collect additional data that could be analyzed during our collective research meetings.

To understand the various resources and ideology that supported the students' movie production, I drew upon the student researcher artifacts, narratives, and interview transcripts and my own descriptive ethnographic field notes. Furthermore, I (and others in the research group) remain in contact with many of these young adults; this allows me to be aware of macrolevel changes in their lives such as moves to new cities, different schools, graduation, college plans, success in school (or not), and employment experiences.

**Understanding Practices Through Sociocultural Theory**

The analyses presented in this paper focus upon identifying and understanding some of the student researchers' embodied cultural practices or ways of being in the world that were drawn upon as they created, developed, and produced their sound movie. Although individuals interact in the world in a multitude
of ways and their practices may differ depending upon the spaces they are within and the way each context feels, thin patterns of coherence become evident in the way individuals act. Whether Shakeem was moving up and down with the beat of the string vibrator or Randy was tapping a meter stick at a lab table as he sang about frequency, the DUS learning environment was rarely devoid of sound, action, music, and dance. Hence, in working with the student researchers, it did not take long before we identified particular patterns of interacting that were similar to the "movement," "verve," and "orality" dispositions identified by Boykin (1986). These three attributes have been theorized by Boykin as being rooted in West African culture and molded by experiences of slavery and oppression in the United States. He discusses movement as "an emphasis on the interweaving of movement, rhythm, percussiveness, music, and dance; verve is "a propensity for relatively high levels of stimulation, to action that is energetic and lively" and orality refers to when "the ability to use alliterative, metaphorically colorful, graphic forms of spoken language — is emphasized and cultivated" (p. 61).

In the movie, multiple segments overflowed with energy, music, and references to rap. In addition, the skits the youth developed and filmed for teaching their anticipated audience about sound in the city drew upon dance, rhythm, motion, and colorful, creative discourse. Moreover, additional data sources, including artifacts produced by the student researchers and findings from interpretive research tasks repeatedly revealed that practices associated with movement, verve, and orality play an important role in students’ development of social relationships and symbolic status with peers, both inside and outside of school. However, it is important to clearly state that movement, verve, and orality are not uniformly or exclusively practiced amongst African American communities. Cultural practices are only thinly coherent since boundaries separating spaces are not rigid; they are porous (Sewell, 1999), and particular spaces may resonate with individuals in different ways and call forth particular practices. Skin color or ethnic roots do not predetermine the dispositions one embodies, rather it is one’s social and cultural history and the spaces in which one participates that shapes unconscious and embodied ways of acting.

Contextualizing Frequency and Pitch Through Embodied Resources

In science classrooms across America, students are taught to use cultural symbols such as language, terminology, formulas, diagrams, and accepted models for explaining physics concepts. This was not very different from the focus in which May, Ivory, Shakeem, Randy, and Kareem initially engaged to understand frequency and pitch. In their initial identification of "sound facts," the student researchers defined frequency as "how fast the molecules are moving; the number of complete vibrations per second" and as "the number of waves that pass a fixed point in unit time." They defined pitch as "the perception of frequency of sound waves." Building upon standard definitions of sound wave frequency and their own embodied resources, the student researchers addressed the concept of frequency in the sound movie in three different ways: auditory discrepancies (pitch), visual representations (diagrams), and real world connections (e.g., skits, performances). The following movie segment shows Shakeem invoking dispositions of movement, verve, and orality to teach other students about pitch through a real world connection. While performing, Shakeem addressed an imaginary audience; he was animated, smiling, and clearly pleased with the activity he was pursuing.

"You Don’t Think That It Mean Nothin’ Scientific, But It Does"

Check it out, right? You know when you around the block, right and you using slang, bang ghetto calls, ya-mean [you know what I mean]? You don’t think that it mean nothin’ scientific, but it does. Check this out when you see ya manz [friend] and you like around the corner and three blocks ahead of you and you can’t just say out his name cuz that’s kinda jo [not cool], you say [Shakeem quickly says COO four times in a high pitched voice, followed by a much deeper, Yurp!] COO, COO, COO, COO! Yurp! You know something like that, right now I just used amplitude, but I’m not gonna get into it. First we gonna start with the pitch. That’s how—Y’all like Musiq right SIQ [Musiq Soulchild]? And in the song, “Love,” he has a very high towards the ending of the song—he has a very high pitch and it goes [Shakeem imitates a high pitch], “love!” And it’s kind of hard to do cuz it’s so high pitch, but in the beginning of the song he starts off like [Shakeem imitates deep, low pitched voice], “love.” And that’s kinda low, so it’s easy to get to.

In this segment of the movie, Shakeem developed a two-fold example to demonstrate the auditory difference in low and high pitch. His performance was connected to cultural symbols that would be associated with fields outside of school; he began with a type of "slang bang ghetto call," a linguistic symbol that was recognizable to May, Ivory, Randy, and Kareem, and
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Perhaps to other students. He then moved seamlessly into an example of the extremes of frequency/pitch through reference to another cultural symbol popular among youth of his age, a song by Musiq Soulchild. As the movie continued, Shakeem took this representation a step further by playing actual sections of the song for reinforcement of the factual point he was making.

Oh so, since ya'll here again. Back to what I was getting to about the high an low pitched voices an stuff. Everyone knows their own example of a real high pitched person. [Let me] Show you somethin’. [Musiq soulchild’s song “Love” comes on in the background and Shakeem mouths the very high pitched lyrics.] “Loooooooooooooooove! So many things I’ve got to tell you, but I’m afraid I don’t know how.” [He stops the music.] That’s enough. Now we all know the high pitch, now we’re gonna go to a low pitch, cuz you know my singin’ is just so sickin’ [cool] like that. I rap, I sing. I do it all. Get ready for somethin’. [As the song plays, this time in a new location, Shakeem once again, mouths the lyrics in perfect synchrony in a deep base tone.] “Love. So many things I’ve got to tell you, but I’m afraid I don’t know how. Cuz there’s a possibility, you’ll look at me differently. Love. Ever since the first moment I spoke your name. From then on I knew that by you being in my life things were destined to change cuz—Love. So many people use your name in vain. Love.” [The scene closes as an imaginary audience cheers—an added sound effect through the video editing software.]

While singing and music in a classroom may traditionally be associated with misbehavior and off-task activity, this sound movie segment illustrates that students’ high energy levels, rhythm, and singing can contribute to their contextualization and connection with scientific abstraction. Illuminated in his statement, “You don’t think that it mean nothin scientific, but it does,” Shakeem became conscious that some of his unconscious practices and knowledge (e.g., ghetto calling, knowledge of Musiq Child lyrics) did mean “something scientific.” Through this experience of trying to make science more accessible to other urban youth, Shakeem had found an appropriate place for embodied dispositions, such as orality, movement, and verve. Being able to participate in science learning environments with practices that are natural and embodied is important for generating positive feelings about and successful engagement in science (Elmesky, 2005). However, even more salient to consider here is how Shakeem’s practices in this movie segment shaped the ways in which other student researchers engaged in discussing pitch and frequency. In fact, Shakeem’s approach to explaining/teaching pitch to an imaginary audience became a resource for the other student researchers, and that was evident in a research group meeting with Randy and Kareem that occurred soon after completing the filming of the segments on pitch and frequency.

Rap, Emotion, and Pitch Fluctuation

In the following transcript, Randy, Kareem, and I engaged in dialogue regarding how rap artists utilize pitch fluctuation for emotional expression and definition of narrative characters. Although the rap lyrics shared here may be offensive in content to some individuals, their inclusion illustrates the ways in which resources from other spaces (such as peer group settings in the neighborhood) became accessed and appropriated in the DUS research/learning environment. Specifically, this vignette demonstrates how Randy and Kareem’s discursive practices and shared knowledge of the genre of rap became a resource for contextualizing abstract science facts.

Kareem: Eminem like stay high through the whole song.
Rowhea: He’d stay high through the whole song? So that might be his signature? Is that the way he always does it?
Kareem: No, it’s just like certain songs. He versatile.
Rowhea: So he’s tryin’ to show some talent, that he can go all the way up or he can go all the way down?...
Kareem: ... he had this other song where he takin his wife out to kill her. He like, he be like, “So long.” [Uses deep sad voice]
Randy: Stay real calm.
Rowhea: Uhuh [yes]
Randy: Cuz they talkin to the baby an then when he talkin to the wife, that when he get—[Kareem starts rapping in a low whispery voice and gets increasingly louder.]
Kareem: ... he had this other song where he takin his wife out to kill her. He like, he be like, “So long.” [Uses deep sad voice]
Randy: Stay real calm.
Rowhea: Uhuh [yes]
Randy: Cuz they talkin to the baby an then when he talkin to the wife, that when he get—[Kareem starts rapping in a low whispery voice and gets increasingly louder.]
Kareem: [His voice, mimicking a harsh male voice, becomes audible on tape.] “Surely, you’ll see what I’m about to do. Shut up, b—. Why you always make me shout at you? How could you leave me an nothin out the blue?” [Kareem’s voice returns to normal.] An then like in the background, it’s like you hear the girl, like [high pitched, scared voice] “Oh, oh!!” But that’s Eminem like screamin’ like a girl, but then when he’s made like he rappin’ an he’s talkin’ to the girl, an the girl talkin’ back, that’s him! He like [Raises the

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have lacked the potential to initiate or appropriately participate had I been interacting alone with one of the rap examples, the discursive practices may have gone unaccessed and unappropriated by the participants. Moreover, the flow and fluidity that emerged as they related the rap examples to the physics of sound (indicated in finishing each other’s sentences or complementing the examples with further details) may have been negligible. Rather, the students were attuned and fluent as they collectively produced and enacted culture to further their understandings of pitch. Their presence in that space formed a condition of resonance—in that their practices resonated with each other and created an opportunity for feelings of inclusion and empowerment associated with the culture of science.

Was It Truly an Empowering Experience?

In reflecting upon the work I have done with student researchers over the longitudinal nature of this study, the creation of this movie was a focal point—a moment of pride in their employment with the grant. Three years after her experience of producing the sound movie, May called me and asked for help with her senior project; she wanted to focus on her experiences as a student researcher and, specifically, on the making of the Sound in the City movie. Considering that she had worked with us for 3 years and engaged in multiple projects, her interest in sharing the movie experience with a new audience (her high school senior classmates and teachers in a new neighborhood school to which she had transferred), following such a large lapse in time speaks to the possibility that the movie production process and the subsequent product were proud markers in her life. As she wrote in her senior project,

"In the movie we made, Sound in the City, we tried to teach kids about sound waves, amplitude, frequency and many other concepts. This is one of the biggest projects I have ever been involved with, and I feel that it was a big success."

In fact, for many of the DUS youth, their participation in the sound movie was somewhat empowering on a personal level, as they became role models for other students in their school and assistants to the science teachers. For instance, at Kareem and Ivory’s high school, the ninth grade students watched the sound movie and subsequently engaged in producing one themselves. As expressed by Kareem,

"But what I learned helped me because I am helping the teacher. I don’t know what their needs are. I...
In addition to helping their teachers, the sound movie production also assisted the student researchers in earning respect from peers within the research group, as well as with school peers who viewed the movie. Respect is important for building status and identity in earning respect from peers within the research group, as well as with school peers who viewed the movie. The sound movie, earning respect became linked to engagement in the science culture. As expressed by Kareem, “We had to learn about it in order to do it. You can’t do it an’ not know nothin’ about it cuz then we wouldn’t be knowin’ what we talking about, then we be sayin’ the wrong things to the camera.” Thus, interestingly, the alignment of multiple objectives emerged as the students began to value participation in science as a pre- or corequisite to meeting their own aspirations and as I came to understand that they could meet science related goals while engaging in practices that would have normally been used to build social relationships and status in other fields.

During the school year immediately following the summer in which the movie was produced, Shakeem paid me a surprise visit with two peers. When he learned that I had a copy of the DUS sound movie in my office, he proceeded to show the movie to Andy and Dawood. Their verbal reactions to the sound movie expressed awe and respect for the student researchers. Andy and Dawood’s admiration first became apparent during the skit in which Ivory talked about the ways human hearing can be harmed. As she spoke, Shakeem quietly approached her from behind and hit a huge water container on the table to generate a loud noise (which was enhanced through a loud crashing sound effect inserted though the video editing software). Enticed by the evil look on Shakeem’s face as he startled Ivory, the young men paused the tape and then watched the clip again, this time in slow motion. According to Dawood, that segment was “the hottest jawn [part] on the tape.”

Later, when Ivory rapped about sounds in the city, Andy exclaimed, “That was freestyle? Oh, she better than me!” Shakeem proudly added in, “An she was rappin’ on some school s——!” As Shakeem rapped at varying speeds (from slow to very fast) to symbolize wave velocity fluctuations through gases and liquids, and solids, he turned to Andy and asked, “Don’t you think that you would learn better if they taught you like that?” Andy responded by nodding his head.

A Product of Agency and a Catalyst for Further Agency

In closing this paper with vignettes of events that occurred following the completion of the Sound in the City movie, I assert that the movie production constituted an empowering experience in both the process and the final product. Through an analysis of Shakeem’s movie segment on pitch and Kareem and Randy’s behind the scene work to further contextualize pitch, the previous sections illustrate how the student researchers exercised agency during the production process by using naturally embodied forms of knowledge in new ways – to contextualize abstract science facts. What resulted was a product that represented a unique mix of cultural symbols and practices from the science and school cultures, as well as from their neighborhoods and school. Moreover, in its completed state, the Sound in the City movie signified both the product of student agency and a new tool for the student researchers to use in new ways and continue to expand their possibilities for action within spaces inside and outside the research group. That is, the sound movie, as a resource that straddled both science and outside-of-school arenas, assisted the students in meeting multiple objectives across various spaces; this was evident in May’s senior project focus, Kareem and Ivory’s assistance to their school’s science teachers and younger youth, and Shakeem’s ability to build respect with his peers.

Coda: “I Am Science and the World Is Mine”

The culture of science, particularly the physics culture, has been and continues to be closed to those who are not White and male. It is not uncommon to visit a high level physics course and see only a few faces, mostly homogenous, staring back at you. It is time to view the boundaries of science as porous not rigid and to insist that science classrooms are more accepting of different forms of resources. Unfortunately, symbolic violence continually occurs when school systems insist explicitly or subtly that the urban youth leave all aspects of their embodied resources outside of school, as if these ways of being are held within a hat that can be taken off and put back on. This approach will not lead to social transformation for these youth, since without having opportunities for their dispositional resources to be accessed and appropriated, their sense of agency is truncated. They will not experience opportunities to learn how to utilize their talents, skills, values, attitudes, or dispositions in ways that are empowering.
As put forth by Roth and Barton (2004), school learning should be expansive and lead to wider possibilities for action. This has not been the case for marginalized populations in the nation’s largest urban centers. Science should be a tool for achieving expanded agency. Certainly, all children should have the opportunity to say: “I am science” — and to utilize their own resources to build new means for making the world theirs.

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