Teaching and Learning Science in an Urban School: Analogy as a Key to Communal Science Pedagogy

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Abstract

This article articulates the results of an ongoing study in an urban school in New York City in which student and teacher researchers engage in practices that support the science success of the schools' predominantly Latino/a and African American population. By situating the study in the nature of corporate and communal practices, the article demonstrates the necessity for an expansion of approaches to teaching and learning that includes students' ways of knowing. Furthermore, the article shows the emergence of analogy as an outcome of embracing communal teaching practices.

For educators and researchers interested in urban teaching and learning, it is necessary to deconstruct the modes of thought and practice that currently influence urban education. It is also important for us to discuss how these factors impact urban schools and communities. As a science educator, I realize that this requires a critical questioning of current societal thoughts on science education. This involves the use of cogenerative dialogues where students and teachers have joint conversations about their experiences inside and outside of classrooms and reach collective decisions about the rules, roles, and responsibilities that govern their everyday lives (Roth, Tobin & Zimmerman, 2002). By employing cogenerative dialogues, we embark on conversations about the culture of urban schools and the complexities of the relationships among the varying factions within these schools.

In order to come into a full understanding of the issues at play within urban schools, it is necessary to acknowledge that in the United States, the general population is conditioned to look at schools as a militarized, orderly place where all students (particularly in science classes) look, sit, and interact in a certain way, learn specified information, and then possibly graduate. Schools function under the premise of western, middle class ideals that mirror economic productivity models of knowledge creation and dissemination determined by the scholars in a specific field (Diamond, 1999). We are further conditioned to see the science classroom as a place where students are trained to be successful at specific tasks, learn a prescribed amount of information and then utilize this information to benefit society (Tyack & Cuban, 1995; Ravitch, 2000). This ideology stems from the historical function of science classrooms as the gateway to the nations' economic and technologic livelihood in the global sphere of science achievement.

In the post Cold War era, we carry notions of a national competition against other countries that was fueled by the Russian launch of Sputnik in 1957 (Kliebard, 2004), and have been focused on a rhetoric for science education that supports economic efficiency and performance based outcomes ever since. These commonly accepted notions on science education abandon

communal approaches that contextualize schools by considering factors like the racial, ethnic, sexual, gender, socioeconomic, and religious backgrounds of students into teaching and learning science. The abandonment of these critical factors can be linked to the populations targeted for success in science (predominantly white males) in the United States and the variance in American mainstream ideologies from those from populations that are more entrenched in communal practices.

Communal approaches to science education are informed by the aforementioned factors and are based on ideologies and practices that critically address difference and values co-responsibility and co-ownership despite difference. These are attributes that are prevalent in populations that value attributes like interdependence among groups and do not fit into the generalized independent nature of achievement of the mainstream American population (Markus & Kitayama, 1991).

In science classes where communal practices are implemented, there is as much focus on the interactions between teachers and students as there is between students and the subject matter. Unfortunately, science classrooms are oftentimes so deeply ingrained in the fabric of corporate practices that are far removed from students' ways of knowing that the perception is that any thing other than a strict adherence to the scientific method, memorization of facts and testing of science knowledge has little use because of its lack of an ultimate, tangible economic return. The result of this practice is to have science education stand as an extension of the hegemonic arm of education in urban schools that serves the sole purpose of maintaining the status quo and valuing meritocracy and economic competitiveness by teaching students to pass exams and not learn the beauty of science, its relevance to their lives and become scientifically literate (Black, 2004; Puk & Haines, 1999). Consequently we see a lack of interest in science that can only be repaired through the enactment of communal practices that reclaim ownership of science and expands agency in urban science classes for historically marginalized students. It is therefore imperative to have an ongoing critique of, and plan to, redesign teaching and learning of science in urban schools in order to move these institutions to becoming more communal and therefore more genuine parts of students' lives (Cook-Sathan, 2002).

The research in this study addresses a seemingly unconventional approach to science teaching and learning that illuminates some of the issues that support transforming science education for inner city students. It reflects the discoveries that emerged from research being done with African American and Latino/a students in physics and chemistry classes in an urban school in New York City.

Student rituals and culturally relevant analogies: Analogy and metaphor as a key to communal practice

In this study, the research has discovered that heightened levels of emotional energy, synchrony, and student interest are achieved when analogies that are culturally relevant to students are enacted in the classroom. These culturally relevant analogies are a staple of student conversations when they try to explain chemistry and physics topics to each other. They are also present when students want to make sense of topics that they find challenging. As a result of this discovery, I echo the sentiment that "expressing an analogy orally and putting it into the public sphere in the classroom can serve as a basis for communication about the object or concept"

(Tobin, Elmesky, & Seiler, 2005, p.123). Furthermore, "the construction of such a figure of speech provides a link between the micro/individual level and the meso level where learning occurs" (Tobin, Elmesky, & Seiler, 2005, p.123).

The discovery of the ameliorating qualities of these analogies occurred via an initial process of having students who were performing well in their physics and chemistry classrooms tutor their peers. Students and teachers studied the videotapes of these tutoring sessions and students extracted vignettes from the videotapes where their peers either appeared to be most engaged in the lesson or that they would describe as examples of good teaching. The selected vignettes almost always included instances where the students used culturally relevant analogies to describe concepts in physics or chemistry.

As a cogenerative dialogue group, student/teacher researchers discussed the emergence of analogy in instances that were described as good teaching. They decided to move beyond these few classroom videotapes and co-generate mechanisms for the establishment of analogy on a more consistent basis in the classrooms. Since student-researchers had identified culturally relevant analogies as a key component of successful interactions, student/teacher researchers decided to look at and discuss practices that stem from the use of analogy and metaphor that may possibly support teachers in their pedagogical practices.

Through conversations with student researchers in cogenerative dialogue sessions about the extracted vignettes, the research uncovered that students not only identified instances where these analogies were used as examples of good teaching but could discuss the scientific concepts described by the teacher more accurately in instances where relevant analogies accompanied the instruction. By studying the ways that students taught each other physics and chemistry concepts, teachers were able to engage in an active process of deconstructing their perceptions of good teaching while reconstructing new approaches to pedagogy based on student perspectives.

With an active process of learning and researching students' lived worlds in place, the teachers were better able to enact culturally relevant analogies and expand the frameworks for teacher and student knowledge on a particular topic. The use of culturally relevant ways of explaining and describing (similes, metaphors, dialects) are "capable of giving us a new understanding of our experience. Thus they can give new meaning to our pasts, to our daily activity, and to what we know and believe" (Lakoff & Johnson, 1980, p.139). They also provide an initial step for teachers to enter into student lived worlds.

As opportunities for use of culturally relevant phenomena expanded in this study, they became an entry point for teacher interest in students lived worlds and caused the teachers involved to be more willing to learn more about their students' lives outside of school. The results of this portion of the study led to the conclusion that in instances where teachers actively searched for and utilized these analogies, they increased their cultural capital with students, became more culturally aware of student perspectives, developed more powerful lesson planning and fostered fluidity in interactions with students.

Symbolic and cultural toolkits in the science classroom

An individual's cultural toolkit encompasses an individual's schema and practices as they combine to create how one interacts within a field (Swidler, 1986; DiMaggio, 1997). An individual's experiences, background, and ways of knowing form a belief system (schema) that is directly related to ones practices (Roth & Tobin, 2002). In many instances, teacher's schema and practices are supportive of assimilation into a corporate science-teaching framework.

Science education courses and professional development offerings often emphasize a command of teaching techniques that focus more on an appropriation of canonical subject matter knowledge than they do on effective teaching and learning techniques for diverse populations.

Teachers' experiences in these courses become a component of their cultural toolkits and are enacted in classroom settings often times as an antithesis to the communal practices that are necessary for transformative science education. As teachers enact corporate culture as a result of the components of their toolkits, the process of making allowances for student culture becomes difficult. Instances where students would be able to provide examples for each other to help support their learning are not allowed to flourish because oftentimes teachers have become entrenched in a strict question and answer model that does not make allowances for students' ways of knowing (Vermunt &Verloop, 1999). The design and planning of lessons that are more communally grounded and culturally relevant to students rarely happens because that structure does not fit into the corporate classroom model and the cultural toolkits that teachers are prepared with.

The move to conscious praxis: From cultural to physical toolkits

In the next step of this study, we began to focus on the development of the cultural toolkits discussed in the previous section and the development of a physical toolkit of analogies that developed as result of this study. Beginning with the observations of increased eye contact, heightened emotional energy, fewer breaks in conversation, and head nods when students explained specific concepts using analogies to their peers, teacher and student researchers looked at instances where these same markers for student interest occurred in the teacher led classroom. When teachers entered the classroom and used analogies both with and without prior planning, the same markers for student interest were present. In addition, as teachers became more closely involved with students' ways of knowing by watching videotapes and observing when students explained work to each other, their actions and dispositions began to change. Teachers picked up practices from students that over time became part of their cultural toolkits.

These new practices resulted in teachers sitting on eye level with students, giving high fives when students responded correctly to questions, and using multiple examples in their explanations of concepts. As a result of the successful evolution of teacher practices and the identification of these new practices as being indicators of good teaching by students, the two teachers involved in this study had developed new schema for their cultural toolkits. Teachers then decided that it would be a good plan of action to identify and write down analogies that students used when interacting with each other. They also decided to use these analogies in their classrooms. This pooling of student analogies describes the development of a physical toolkit of analogies that accompanied their cultural toolkits. An example of this is described in the vignettes below.

Eric: Potential energy is like when somebody is getting picked on like everyday just taking it in, like storing the energy, then when they spazz out and flip out on somebody and get in a fight that's kinetic energy.
Brian: Oh aiight, I see that

One week later:
Mr. E: So potential energy is stored energy, sort of like if someone is getting picked on, storing all the anger, that's like potential energy. And Kinetic? Well you know what happens next. Who knows what will happen next?

Culturally relevant analogy and student notions of authenticity

In instances where the analogies being used by teachers were developed and previously used by students, student responses to the teachers' instruction dramatically increased. Evidence of this was seen in students volunteering to participate in class, willingness to ask/answer questions, and students volunteering to explain physics concepts to their peers.

After creating lesson plans on specific topics utilizing student analogies, the teachers decided to use additional information from cogenerative dialogues, and individual studies of the students' ways of teaching to develop their own culturally relevant analogies for upcoming lessons. While this process was initially challenging, the teachers involved slowly became more fluent in the ability to create such analogies and utilize them in the classroom. The physical toolkit began to consist of analogies that students used and also analogies that teachers developed by engaging in communal practices with students. While these analogies were not the main driving force in the science classrooms, the teachers used them when students were struggling with a concept or when a vivid example was necessary for the articulation of a specific concept. The consistent use of these types of analogies in the classroom either established or solidified the teachers' authenticity, created opportunities for distributed classroom management, and eliminated the occurrence of behaviors that were not conducive to science learning.

Analyzing the authenticity component

While the discovery of the ability of these analogies to improve classroom interaction has become evident, the research in this study also uncovered that analogies have the ability to radically change student perspectives of teachers. The use of culturally relevant analogies assisted teachers in developing the cultural tools necessary to meet the authenticity criteria required of any new member of the students' worlds.

In this study, one key theme that emerged from cogenerative dialogues was that students listened to rap music daily and utilized rap music analogies in their peer teaching. As a result of this discovery, the cogenerative dialogue group delved into a discussion of music and artists and why students listened to particular artists. The main question that surfaced was "What makes a rapper a good emcee?" Student responses exhibited that the authenticity criteria for a culturally relevant artist involved "making you feel like they know where you're coming from" and "having sick similies and metaphors." These authenticity criteria were then juxtaposed with the question of "what makes a teacher real?" and "what makes a teacher a good teacher?"

The authenticity criteria for a teacher were analogous to the requirements that students had for the rap artists. Student responses to the question of "What makes a teacher a good teacher?" included responses like "understanding where the student is coming from" and "having good examples in class." These results display that the interpolation of culturally relevant analogies and stories into the teachers' repertoire helps the teacher in meeting the students' authenticity criteria for being relevant and a good teacher.

Cultural relevance across fields: Actualizing theory as it informs praxis

In this paper, I transition back and forth between analogy and cultural relevance and look at how my focus on culturally relevant analogy was birthed by an interest in, and valuing of, student culture. These discoveries could not have been made without cogenerative dialogues. These sessions not only served the purpose of having students and teachers enact and sustain ongoing conversations about their lives and experiences, but they also helped to develop the "three R's: relationships, rigor, and relevance" which are central to improving student motivation, achievement and school engagement (National Research Council, 2004).

Learning from student rituals and transforming urban science instruction

Utilizing culturally relevant analogies in the science classroom requires both a thorough understanding of the subject matter (chemistry, physics) and a familiarity with topics that are relevant and of interest to students. The only means by which either of these two knowledges is attained is by an active and ongoing quest for a command of the nuances that encompass both the academic subject and the students being taught. The teachers in this study gained a command of physics/chemistry knowledge, by continuously teaching and learning the material, attending content related professional development, taking courses towards advanced degrees, reading textbooks and supplementary material, and researching the topics that will be discussed in class. It is often not viewed as pedagogically necessary for teachers to exercise the same rigorous practices when it comes to becoming versed in students' modes of interaction, discourse, interests, and family life.

The argument being presented here is that the same process that is undergone in gaining content knowledge in the subject matter is necessary in gaining knowledge about students' backgrounds. This occurs with the teachers' awareness of the differences in teacher and student knowledge in science and in culture, and with a respect for what the student offers to the act of pedagogy. It also requires the teachers' willingness to acknowledge that they often know less about the students' lived worlds than the students know about the subject matter. The enactment of communal teaching and learning practices in urban schools leads to the emergence of tools like analogy in teaching practice and is the key to fostering student interest and success in science and education.

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