Conceptual Continuity and The Role of Linguistic Relativity in Science Teaching and Learning

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Vexation

As I enter my 12th year as a science educator, I have come to realize that I am only comfortable with science teaching in one context. That context is often described with phrases like "Urban Schools," and "Underprivileged." Within these labels I find myself searching for the subtexts of these labels. Unfortunately, these terms have been used as code word for perceived deficiencies of Black and Brown students. As a result, I am find myself challenged with the responsibility of altering these perspectives because experience has taught me that within these urban schools are highly intelligent, highly motivated students who are continually underserved by a culture of education that fails to recognize their talents and interests.

Seen in this way, urban schools are often microcosms of cultural conflict. On one hand, teachers appropriate an empathetic position that postulates that students would be better off if they took on cultural characteristics of the teacher. By contrast, students rarely look at these teachers' symbols of the American dream of the successful life. In the end, many of these classrooms evolve into a culture clash where students attempt to maintain an identity that teachers continually try to alter in the name of teaching science.

As these cultures clash, science often serves as the epicenter of these great culture clashes. Science with its own way of thinking, writing, speaking, and behaving provides ample opportunities for these conflicts to manifest. As a result, students often see the appropriation of cultural characteristics commensurate with science learning as symbolic of cultural betrayal (Brown, 2004; Gilbert & Yerrick, 2001). Conversely teachers in these urban contexts often find themselves in a position where they struggled to motivate students to participate in science.

Given this perspective, what vexes me is science education's refusal to recognize how science is "a way" to understand the world as opposed to "the way" to come to knowledge. Due to the cultural hegemony of science the discourse practices, conceptual frameworks, and symbol systems of science are used as proxies for the concepts themselves. Such a perspectives renders the intuitive modes of scientific discourse, conceptual understanding, and scientific symbol systems incompatible with far too many students' ways of knowing. Said differently, if students' intuitive ways of understanding are not valued because they are not represented through science discourse, we will be unable to recognize the value of students' intuitive science understandings. In this way, I am vexed to understand how to help teachers understand what to do with students 'so-called wrong answers.'

Perhaps the best way to explain this vexation is to offer an example. When students were asked to explain why they have never seen an obese competitive marathon runner, the following conversation ensued:

D'Andre: It's basically because they be sweatin'.
Teacher: That's good. What does sweat have to do with it?
Tanisha: It's because they always be hot. They be hotter than everybody else. My cousin always be sweatin'.
Steve: It's cause they fat Blood! [laughter] They get hot and they always be sweatin'…even if they just walkin' up the stairs.
D'Andre: Naw! It's like this. It's like if you set a block of ice out. Out on the curb. The ice don't just melt. First, it just turns into water. Then, the water it disappears into steam. It's like that. It don't be no fat marathon runners because when they run, they melt the fat and they body use the fat and it burns off.

This excerpt provides an example of how conceptualization and scientific language use may limit a teacher's capacity to assess students' scientific understanding. First, D'Andre's description of the process of using fat for energy is void of the traditional scientific terminology that provides an ability to distinguish between types (Anabolic and Catabolic) of metabolism. Despite not using those terms, he expresses a tenuous understanding of the way fat is used for energy. Without using canonical scientific terminology, he explains how fat is converted to another form for human use and is subsequently used for energy purposes. His selection of an analogy to explain this process provides him an effective resource for explaining the scientific phenomenon, but does not allow him to benefit from the taxonomical and organizational specificity of scientific discourse.

The challenge that emerges in analyzing the value of this excerpt lies in understanding what to do with D'Andre's discourse. Additionally, it is important to understand how the use of D'Andre's discourse signals his Discursive Identity and has potential to impact his role in the social order of this classroom (Brown, 2004; Brown, 2005; Valeras, 2006). Although he presents an insightful understanding of the concept being discussed, D'Andre's learning must extend beyond his vernacular understanding of science language towards an understanding that includes both science language and other associated discourse practices. These other discourse practices include the ability to understand and produce images, tables, and symbols that help students conceptualize the concept of metabolic activity. In appropriating science discourse, he will gain the taxonomical and organizational resources embedded in being able to 'talk science' (Lemke, 1990). What is often lost in urban education is the

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ability to value and affirm D'Andre's discourse because teachers may not recognize it as valuable in their classrooms. As a result, I am truly struggling with how to help teachers recognize the value of students everyday discourse practices for learning on two levels. First, how do these language practices maintain a value, or Continuity, with the language practices valued by science classrooms? Second, how would alternative approaches to using language effect students' learning, identity, and perspective of science?

Venture

I venture to explore *Conceptual Continuity* as a framework for understanding how to craft learning environments that maximize the relationship between students' native ways of understanding phenomenon and its connection to those ideas as represented in science teaching. This has the potential to add intellectual depth to contemporary perspectives regarding the nature of science learning. I propose the exploration of the notion of *Conceptual Continuity* as a framework for understanding how to craft learning environments that maximize the relationship between students' native ways of understanding phenomenon and its connection to those ideas as represented in science teaching.

Research studies regarding the ways young people come to learn science led to the development of learning theories designed to describe the ways young people come to understand the world. Strike & Posner (1992) introduced and later revised a "conceptual ecology" as an overarching rationale for understanding how students come to understand phenomenon. This framework, commonly know as Conceptual Change, explained how students advance from intuitive understandings towards reconstructed scientific understandings. Although, conceptual change has been widely accepted as a theory for understanding student learning, it is not without its critics.

One of the primary critiques of this work involved claims about the limits of its effectiveness. Scholars argued that conceptual change is limited because it only describes learning that occurs when students hold a clear understanding of a phenomenon. Vosniadou (2002) challenged conceptual change by arguing for a more gradual alteration of students' perspectives. Vosniadou claimed that students changing perspectives are gradual rather than drastic. Chi and Roscoe (2002) argued that misconceptions are merely erroneous categorizations of concepts, which would make conceptual change a simple reassignment of concepts.

diSessa's (2002) argument added a critical extension to conceptual change frameworks by identifying how conceptual change perspectives serve as foundational transformations between native understandings of the world and their scientific counterparts. This research seeks to extend this theoretical argument by proposing the concept of *Conceptual Continuity* as a theoretical perspective from which to understand how students' naïve understandings of science ideas serves as useful resources in the learning of new scientific concepts. Conceptual continuity is built on a premise that learning academic language is central in students' science learning. Therefore, changes in learning are rooted in understanding new concepts. They are also rooted in students learning the language associated with that concept. *Conceptual Continuity* proposes an extension to contemporary perspectives by suggesting that studying students' conceptual acquisitions will reveal how there are continuities between students' erroneous answers that can support their science learning, if we recognize that these understanding contain differences that are both linguistic and conceptual.

A situation for discussion:

A pilot study of this perspective revealed that students' informal learning of physics paralleled some of the primary conceptual understandings commonly understood in physics. Although these answers did not adhere to current models of science language, the students' answers provided evidence of their rich understanding of physics. We explored the types of linguistic practices used by students to make sense of their scientific understandings and noted how they were able to develop a dynamic set of linguistic resources that addressed key component of the Physics behind why curveball's curved without using science language.

This importance of this venture crosses theoretical, professional development, and empirical grounds. From a theoretical perspective, the results of this study have the potential to call attention to the need to consider *Conceptual Continuity* as a framework for understanding students' science learning. These findings have the potential to add to contemporary theories of science learning by challenging the paradigm of teaching from an assessment of right and wrong answers towards and teaching that accounts for demonstrations of levels of correctness.

From an empirical standpoint, the findings call to question the need to see scientific words and scientific concepts as distinctively different. Lastly, the results of this venture have implications for teaching and professional development. Applying conceptual continuity as a teaching approach requires the teacher to use formative assessment opportunities to identify layers of correctness. Such an approach would make the design of classroom environments radically different.