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PART III
Creating Multicultural Classrooms

Are Disciplinary Distinctions Pertinent to Multicultural Education?: A View From Science

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In this article I ask whether disciplinary distinctions are pertinent to multicultural education. Are pedagogical prescriptions aimed at providing access and success to students of diverse backgrounds equally applicable across domains? I review cross-cultural cognitive research to depict defunct deficit and extant pluralistic approaches to diversity. I present 2 predominant approaches to multicultural education in science and situate them within dimensions that characterize general multicultural education research. I argue that the nature of different disciplines—their position and status in the broader society—influences how comfortable we are with instructional versus epistemological pluralism in multicultural education. What appear to transcend disciplinary boundaries are central questions concerning the goals of education; mainly, whether education is conceived as a medium for social reproduction or as a vehicle for self-actualization.

Is multicultural education an important dimension in science education? I draw on Bennett's (2001) framework for defining multicultural education as endeavors aimed at enabling all children to reach their full potential while building on a grounding assumption that knowledge is contested and constructed. These assumptions and goals involve research around curricular and pedagogical action that strives to achieve equity-oriented transformations at the individual as well as societal level. Therefore, I ask whether pedagogical prescriptions aimed at providing access and success to students of diverse backgrounds are equally applicable across domains. I focus in particular on the domain of science.

On the surface, there is little reason to believe that multicultural education models should be domain specific. However, the privileged status of science in society, and the extent to which scientific practices do or do not permeate everyday life, motivate a closer examination of these issues. In this article, I review cross-cultural studies of cognition and pervasive approaches to multicultural education in science teaching to address these questions.

Multiple Languages Multiple Discourse Patterns

O. Lee and Fradd (1996) examined the discourse patterns of linguistically diverse students as they engaged in science activities. These activities included ones in which the students tried to determine why objects sink or float by experimenting with different materials (e.g., rubber ball or clay boat) and a tub of water. The three language groups included native English monolingual speakers, Haitian–Creole and Spanish–English bilingual speakers. Although there was variation in the speech patterns within each group, there were also group-level commonalities that were discerningly different between

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the three groups, such as length of turn and wait time between turns.

The discourse patterns exhibited by the native English speakers were the closest to the predominant patterns found in science classrooms. Students who use these patterns are often attributed with a deeper understanding, whereas those who diverge from these patterns are attributed with difficulties and misunderstanding. For example, a longer wait time prior to responding, as exhibited by speakers of Haitian–Creole, can be interpreted as an inability to respond, and the teacher may even supply the response him- or herself or turn to another student before a response is supplied by the student. A response involving many repetitions can be viewed as a sign of incoherence and as inconsistent with the causality and parsimony expected in science.

Diversity as Deficit

There are a number of examples of how this misalignment (O. Lee, 2003; O. Lee & Fradd, 1996, 1998) between the cultural norms maintained in particular classrooms and those of minority student groups can lead to communication barriers as well as to the exclusion and marginalization of these students. For example, Brice Heath (1983) pointed out that White teachers tended to state directives in the form of indirect requests or questions, such as "Would you like to take your seat now?" or "Is this where the scissors belong?" whereas African American teachers were more likely to make explicit directives, such as "Put the scissors on that shelf." African American students had a hard time interpreting the indirect requests of White teachers as directives rather than as genuine questions or true alternatives. As a result many African American students were perceived as disobedient.

Another example focuses on how different social arrangements and norms of participation conform or diverge from students' community life and therefore promote or impede students' participation. Philips (1972) studied Native American students in school and in their community. These students were considered low-achieving students who were reluctant to participate in class. Philips found that the students' participation was actually a function of the types of participation structures that were employed. Participation structures that were similar to the students' community life, such as the communal nonhierarchical interactions that take place when a group of students work together, invited participation from Native American students. However, participant structures that were foreign to the students, such as whole-class discussions in which the teacher controls the content, flow, and right to speak, deterred the Native American students. Participant structures that were not aligned with the students' cultural capital were the norm; thus relegating Native American students to the fringes of the classroom and labeling them as unable to take part in the intellectual life of the classroom. In contrast, more congruent participant structures can foster higher levels of productivity and engagement (Au & Mason, 1981).

Cultural misalignment occurs not only in the roles and norms of turn taking, but also in the norms for the form of talk. In the context of science classrooms, Michaels, O'Connor and Richards (1990) documented such a disparity between the expectations of an English speaking teacher and a Haitian–Creole speaking student. Although the student understood the concept of equilibrium, she had a hard time demonstrating this understanding because she was not adept with the "why–because" speech pattern by which the teacher orchestrated the discussion. In particular, the student did not realize that "why" was targeting information about the mathematical procedures that were employed as opposed to how the knowledge was obtained (e.g., guessing or figuring out).

Diversity as Pluralism

Cultural differences exist. What bears on issues of equity and access to learning are the ways in which these differences are conceptualized. Increasingly, pluralistic models are replacing deficit models. Research programs in cross-cultural psychology, such as those undertaken by Cole and Scribner (1974) and by Cole and colleagues (reviewed in Cole, 1996) have contributed to these trends. This work was launched against the backdrop of a history of deficit models depicting non-Western and non-Europeant cultures, particularly oral cultures, as failing to achieve the same levels of abstract thought attributed to Western literate cultures. Such beliefs were refuted by Cole and colleagues. Moreover, these programs of research were able to expose the deficits of Westerners when trying to engage in indigenous cognitive practices.

For example, in a classification task that was administered to members of the Kpelle, participants were given 20 objects that could be divided equally into groups of food items, eating utensils, containers, and clothes. The classification that typifies formal operations (the highest developmental level) according to Piaget's scheme is a thematic or taxonomic classification. However, the participants repeatedly placed the objects into groups according to a functional classification. Instead of arranging a group of utensils and a separate group of food, the participants would place a potato together with a knife, explaining "You take the knife and cut the potato. That is how an intelligent person would sort the items." The researcher tried repeatedly to present the experimental task in different ways with the hope that the participants would use a thematic classification. Finally, in a moment of exasperation, the researcher cried, “How would a fool sort the items?” The participants immediately and quickly sorted the items according to thematic categories that matched the ideal classification that the researchers expected (Cole & Scribner, 1974). Thus, the Kpelle, as well as other cultures, were not inferior intellectually, but they had a different set of values and expectations. Sophisticated actions to a Westerner were considered foolish to a Kpelle, and vice versa.

Inspired by the rich set of ideas and intellectually complex indigenous practices that Cole and his colleagues observed in the day-to-day life of the Kpelle they created an inverse cross-cultural experiment (Cole, 1996). They constructed a task that required complex reasoning but was based on objects and practices from the Kpelle rather than Western life. The Kpelle grow and trade in rice. In rice trading they employ a number of containers of different capacity, the smallest of which is the Kopi, which is equivalent to a pint, and serves as a unit of volume. Participants were presented with bowls containing different amounts of rice and a Kopi, and they were asked to estimate how much Kopi of rice was in each bowl. The participants included a group of Kpelle and a group of Americans. The Kpelle were very accurate with 1% to 2% errors in their estimations, whereas the Americans overestimated the amount of rice by 30% or even 100%. Therefore, people of Western culture can appear just as inept when trying to tackle tasks drawn from non-Western cultures as non-Westerners had traditionally appeared when tackling Western tasks.

Two Approaches to Multicultural Education in Science Teaching

The abandon of deficit models and increased appreciation for cultural pluralism has prompted an interest in developing curricula and instructional approaches in science that are more inclusive of diverse students. There are two central approaches to multicultural science education, referred to by Good and Demastes-Southerland (1995) as Instructional Multicultural Science Education (IMSE) and Curricular Multicultural Science Education (CMSE).

IMSE

IMSE considers science to be Western modern science and that the goal of science education is to enculturate students into this way of thinking and doing. One of the principles underlying this approach is that by helping diverse students become versed in Western scientific thinking we are empowering all students and providing them with the tools that are essential for competing and succeeding in society.

Despite the privileged status of Western science that this approach adopts, it recognizes that cultural differences in the orientation that people take toward the production and communication of knowledge do not represent a deficit. Nonetheless, the disparity between these ways of knowing and those that govern typical science classes can pose barriers to learning. As long as the predominant patterns of discourse and practice in science classrooms are those of the mainstream culture, we will unnecessarily exclude some students from acquiring scientific literacy. Therefore, it is critical to recognize multiple ways of reasoning and constructing knowledge, and to offer a place for these alternative paths in science classrooms. However, this approach posits that these alternative paths serve as a bridge toward Western science and not as the ultimate goal of science education.

Although not explicitly associated in the cited report with either instructional or CMSE, the research of Warren, Rosebery, and Conant (1996) can be taken as a successful example of how sensitivity to the diverse knowledge practices of students can bridge between language minority students’ everyday ways and normative science. Warren et al. examined a science classroom of native Haitian–Creole speakers who studied the characteristics of sound. In this class, the teacher presented a software package that displays graphical representations of sound waves of sound recorded through a microphone connected to the computer. The teacher tried to organize a discussion around the creation of different sounds, their graphical representations on the computer, and the use of concepts such as pitch and volume. The discussion was structured in the ubiquitous Initiation–Response–Evaluation pattern, and the students were rather passive and did not seem to display a significant understanding of the graphs and their relation to these concepts.

Later in the curriculum, a local artist helped the students build three African drums that were to be used in an upcoming traditional Haitian ceremony in a school assembly. The teacher encouraged a group of students to create representations of the sounds produced by the different drums. At first the students worked with the drums and the graphical representations at a descriptive level. They produced different sounds and described the resulting graphs, using self-created terms, such as mountains, to describe the different shapes that they saw. However, with time, their work became more scientific as they began using the representations to examine different ideas and questions such as whether a metal or tin drum (i.e., a deeper sound) will produce more mountains.

In subsequent whole-class discussions the teacher related these ideas and made-up terms to formal scientific concepts and terminology. The transition to formal science was further exemplified when a student in the class challenged the students who worked with the drums and contended that they should repeat their recording so that the audience can believe them and accept their claims concerning what the displayed graphs represent. The sound wave representations that served initially as a simple game of tweaking inputs and observing outcomes became a tool for scientific investigation to test and defend hypotheses. In addition, as part of the discourse that the use of these representations engendered, the class, as a community, developed criteria, such as replication, for judging knowledge claims that reflect scientific norms.

In turning to the use of the drums as a way to examine the characteristics of sound waves, the teacher provided students with a point of entry in which they felt comfortable and could exhibit competence. Examples that are typically used in science classrooms to explain sound waves may have been outside of the students' experiences and may have positioned them as inept. In this example, students were allowed to present their findings using their own made-up terms (e.g., mountains) rather than scientific terms (e.g., pitch and volume). This is in contrast to the examples discussed earlier where answers that do not conform to a particular formal scientific pattern are rejected, and thus students are not given an opportunity to cross the bridge between their everyday or ethnic cultures and the culture of science.

Suppose that this type of bridging does occur and students of diverse cultural backgrounds adopt formal Western scientific practices. They are still in a position in which the predominant and preferred ways of knowing, doing, and talking are those that diverge from their cultural heritage. An implicit message that such a curriculum might convey is that the students' own cultural capital might serve a purpose initially, but that eventually if students want to progress and succeed they must leave these practices behind and replace them with the alternatives offered by the mainstream. An important question that educators must face is the impact that these messages might have on students' sense of identity and self-image (see a similar argument and review of similar arguments in Gay, 2004). Therefore, there has been some criticism that the IMSE approach, which privileges Western science, can be construed as a culturally biased and hegemonic approach (e.g., Stanley & Brickhouse, 2001), even if it tries to recognize and respect students' cultural diversity.

CMSE

The second approach to multicultural science education, CMSE, contends that Western science is not the only valuable and legitimate way to examine, understand, and describe the natural world. Thus, we should include additional, ethnic perspectives as equally important and significant goals of science education. Such an approach can mitigate some of the alienation experienced by many science students, particularly those of non-Western cultures and actually better equip them to contend with Western society (Aikenhead, 2001b).

For example, Western science, tends to consider animals, such as the wolf, in terms of classification, typically Linnean, focused mainly on the structure of the organism (Aikenhead, 2001b). Yet, the Cree focus primarily on behavior when thinking about animals. This knowledge is often conveyed through stories that depict the behavior as a function of the interrelationship between the Cree and other living creatures. The Cree ask "Who is the wolf?" whereas Western science asks "How is the wolf classified?"

Another example is the discrepancy between Western scientific and other cultural approaches to observation. In Western science the observers, the scientists, are conceived as external to the objects or situations that they observe. The assumption and expectation is that the observation is objective, and observation is associated with seeing. In contrast, in the Cree culture, the observer is part of the observed. It is not an insider–outsider constellation, but a web of interaction involving all senses (Aikenhead, 2001b).

Proposals for specific curricula based on the CMSE approach, such as those proposed by Aikenhead (2000, 2001a), tend to emphasize learning about science over cultivating young scientists. There is certainly an attempt to develop a deep understanding and acquire skills in the multiple sciences represented, such as Western and Cree. However, these skills and understandings are developed from the perspective of researching science itself to appreciate and critique the different ways of explaining the natural world.

Similarly, Stanley and Brickhouse (2001) suggested learning science through cross-cultural case studies. In this approach, each perspective, indigenous or Western science, is examined within the context of the cultural framework in which it was conceived and enacted. Thus, the basic tenets and assumptions of each perspective, including Western science, which can be tacit or invisible, are made explicit to students. Therefore, Stanley and Brickhouse emphasized the contribution that this approach could have for all students—not just students of non-Western heritage.

Is the Reception of Curricular Multicultural Approaches Discipline Bound?

The IMSE and CMSE approaches both resonate well with many of the ideas proffered by general multicultural education research (e.g., Banks, 2004; Bennett, 2001;

Gay, 2004), although each approach coheres with a different set of propositions. Banks articulated five dimensions of multicultural education research. *Content integration* deals with the extent to which teachers use information from a variety of cultures to address the given curricular content. *Knowledge construction* encourages instruction to describe the process through which the various disciplines construct their knowledge and the implicit cultural assumptions that influence and shape this process. *Prejudice reduction* focuses on overcoming students' cultural biases. *Equity pedagogy* strives for instructional approaches that advance the academic achievement of diverse students. *Empowering school culture* deals with the ways in which schools can be structured to allow for diverse students to experience equality and empowerment. Equity pedagogy and empowering school culture are two dimensions that do not immediately relate to the issues raised in this article.

IMSE and the illustration of instruction on sound waves using traditional drums and visualization software represent the content integration and equity pedagogy dimensions. These initiatives, both in the general multicultural education arena and in science education, do not explicitly challenge mainstream perspectives and Euro-centered curricula. The knowledge construction dimension is more polemic. On one hand, an emphasis on uncovering grounding assumptions and the processes through which knowledge is derived bode well with extant interests in promoting an understanding of epistemology among students (Hofer, 2001; Hofer & Pintrich, 1997). On the other hand, this approach can also challenge ideas that have been regarded as a staple of the core curricula and, as we have seen in the case of science, invite the inclusion of differing or competing perspectives into the sanctioned standard curricula. Consequently, the CSME approach is subject to contention and resistance, whereas the IMSE approach is not as controversial, or at most is regarded with ambivalence (Stanley & Brickhouse, 2001).

One reason for the general discomfort with CMSE is that it marks a departure from the predominant focus of research and practice in science education. For many years efforts in science education were directed toward developing means for fostering scientific (Western) conceptions, such as Newton's laws, the theory of evolution by natural selection, and scientific inquiry skills such as systematically controlling variables. Although recent trends have deemphasized conceptual knowledge in favor of a stronger emphasis on skills, there is still a concerted effort directed toward developing particular ways of knowing and doing that reflect Western science. This might distinguish science from other disciplines, which might place a higher premium, for example, on self-expression over particular forms of expression.

To what extent has a discipline seen as its educational goal the enculturation into particular ways of knowing and doing? To what extent has the mainstream perspective come to reflect more pluralistic perspectives? It is possible that the nature of different disciplines—their position and status in the broader society—influences how comfortable we are with instructional versus epistemological pluralism.

For example, C. D. Lee (1995), who developed an approach called Cultural Modeling, studied predominantly in literature education in an Afro-centered school. Lee built on African American students' familiarity and proficiency with a language device called signifying—using intonation and meaning to create multiple meaning and innuendo. Lee used signifying to discuss formal literary strategies such as the use of metaphor. Signifying and metaphors are presented as literary devices that different people use for different goals. They are presented to the students so that they become familiar with these methods, understand them, and critically examine the texts in which they appear.

We can view metaphors as analogous to the concepts and methods of Western science, and signifying as analogous to Cree science, and C. D. Lee's (1995) Cultural Modeling approach as analogous to CMSE. Yet, unlike CMSE, Cultural Modeling has been favorably received (Bennett, 2001; Gee, 1996; Weber, 1993). What might explain the difference in the way these two similar approaches have been received is the difference between the two disciplines in which they are implemented. Signifying has permeated mainstream literature in a way that indigenous science, such as Cree science, has not permeated Western science. Signifying is used primarily if not exclusively by African American writers. Yet, some of these writers, such as Zora Neil Hurston, Alice Walker, and Nobelaurate Toni Morrison, have achieved broad appreciation and acclaim, and their writing has been incorporated into many college curricula (Cain & Graff, 1994). In the case of Cultural Modeling and literature education it seems that changes occurred at the societal level and were adopted at the school level, whereas in the case of science, it seems that school level changes are vastly preceding societal changes. Precipitating societal change may be too onus a task for schools, particularly in politically and economically charged disciplines such as science.

The CMSE approach also raises additional dilemmas. Mainly, how do we decide which non-Western sciences to adopt or represent in the curriculum? Is every individual perspective that a student offers considered an alternative but legitimate way of explaining the natural world? Is the Cree science adopted, but not that of the Kpelle or of Feminist science? Who is to make these decisions and what criteria are to be used? Adopting the CMSE approach inevitably catapults science education curricular decision making, and any similar approach in other disciplines, into a political and moral arena.

In conclusion, traditionally science teaching has privileged some groups, whereas curbing other groups' ability to build on the full range of competencies that they bring to the classroom. To promote scientific literacy among a broad range of students, we must design instruction that is more aligned with diverse practices (O. Lee, 2003; O. Lee & Fradd, 1998; Rosebery, Warren, & Conant, 1992). The question is, where do we position Western science in defining the goals and methods of science education? Although I have noted that multicultural considerations in science education might be distinct from other disciplines, the central issues are broader and pertain to the ideological stance that we take concerning the role and goals of education. Is education perceived primarily as a medium for social reproduction or as a vehicle for self-actualization?

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