Beyond the "Decorated Landscapes" of Educational Reform: Toward Landscapes of Pluralism in Science Education

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ABSTRACT: Perhaps, we are at the fork in the road when it is imperative that we consider whether the pursuit of pluralism in science education is a worthwhile endeavor in light of recent educational reforms that seem to decorate the true aim of education. The "decorated landscapes" of educational reform concentrate on economic growth and do little to promote the conservation of Earth's natural environments that sustain life itself. Here we renew a discussion of a 300-year pursuit in the United States toward educational landscapes that contribute to students' lives. We connect with scholars who have pursued the pluralistic landscapes of culture in an attempt to make education more authentic and democratic and with scholars who have pursued an education for the conservation of the Earth's natural environments. We argue that these two educational domains are and necessarily should be reflective, reliant, and reciprocal of each other if we wish to truly engage students in scientific literacy—the authentic, relevant, and meaningful science education experiences

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that contribute a person's existence. Finally, we offer recommendations which aim to focus on the many meaningful landscapes that contribute to pluralistic life in science education.
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Bears stand upright and, like us, have frontal, binocular vision. They are dexterous and can rotate their forepaws. They snore when they sleep and cuff their cubs when the youngsters mess up. The bear is an omnivore, the only one much larger than we are.... Bears remind us of what we might have become if we had not left the wilderness to live in villages, towns, and suburbs.
–Doug Peacock (1990, p. 76)

INTRODUCTION

At zoos, it seems that many people never fully realize how much the place itself contributes to (or detracts from) the existence of its inhabitants. One zoo has recently constructed a new *Black Bear Habitat*. This exhibit is designed to simulate the woodlands of the bear's natural environment and is decorated with ersatz waterfalls, trees, and caves. There are several locations where one can overlook this replicated environment to see the black bears spending their day lounging or milling around. Several placards are posted that depict the black bears' importance in the bioregion and the interactions between the bears, native peoples, and colonial settlers. Within a man-made tree, there are windows for observing the black bear in an adjacent cave, often sleeping up against the glass. The formidability of this animal is striking to zoo visitors and can be seen on their faces. Most visitors tarry for only a few minutes gazing into the bewildering eyes of *Ursus americanus*. However, the question remains: does this decorated landscape contribute to the existence of the bear?

The zoo habitat designers surely tried to construct an environment to make the black bear feel "at home." Thus, large boulders and a waterway were shaped out of concrete and surfaced to resemble a natural landscape. Simulated tree trunks were placed horizontally and upright to provide shade, and climbing obstacles and pools were created so the bears could cool off on hot summer days. The habitat was completed with grass, a tractor tire, and a big rubber ball, the latter for the bears' entertainment.

At first glance, the bears' habitat looks like a nice place to reside. Perhaps, visitors do not notice or care that this created space is not exactly like the real habitat. Zoo designers intended to provide both a recreational opportunity for visitors to the bear habitat and an opportunity to learn. Unfortunately, human recreation and learning comes at the expense of the bears' quality of life. For instance, there are not many fake trees in the habitat because too many trees might obstruct visitor views or create too much shade. Perhaps, a larger space would be better for the bears, a zoo habitat that would allow the bear to roam corridors to different environments, like their natural habitats, which would communicate to visitors that bears do not stay still, they roam around. In nature, black bears inhabit large living spaces, with yearlings ranging 1–2 miles, adult females 2–6 miles, and adult males 8–15 miles. But of course, such a zoo habitat would be expensive to construct and might frustrate visitors who came to one location when the black bears were at another. Perhaps, GPS microchips could be implanted in the bears that would blink on a map to tell visitors exactly where to find them. Of course, this would mean no privacy for the bears—another lost point in learning about bears because, in nature, bears avoid people and like places of quiet and solitude. Thus, visitors miss learning that black bears need a diverse environment to meet their different needs at different times. What is left is landscaping that may resemble a real bear habitat, but in reality is far from it. In the final analysis, the vague semblance is

unsatisfactory in both educating the visitor and providing habitat for the bear because bears need many *different* kinds of places (just like people).

Looking at the situation from the bear's perspective, what she or he sees is hardly a natural exhibit of *Homo sapiens* either, who generally do not spend their lives walking around eating popcorn and drinking from cans. Where are the shopping centers, gas stations, housing developments, and skyscrapers? So, if the goal is a *meaningful exhibit*, and the desired *meaning* is not communicated, the desired educational outcomes may not be achieved, and, in fact, misconceptions may be inadvertently created, especially when what is remembered by the visitor is landscaping that *decorates* rather than contributes to the bear's existence.

Amidst the current reforms in U.S. education and despite the best intentions, we find similar "habitats" that miss the mark such as classrooms transformed by the rigors of educational research (Eisenhart, 2005a, 2005b; Eisenhart & DeHaan, 2005). Some of this educational research was intended to provide landscapes to reduce the achievement gap and provide accountability within very different school settings. However, have we examined whether this research decorates or truly contributes to the existence of our students?

Comparing bears in zoos to students in classrooms may evoke a reaction of incredulity. Yet, most of us take for granted that our children's classroom is truly educative and not simply decorative like the bears' habitat. These questions then about the school landscape and what it is contributing to students' lives are critically important to ask. Have we not become *desensitized* to the perils of decorated landscapes? Decorated landscapes come in many scenic forms: national standards, mandated testing, 10-pound textbooks, and reams of worksheets. Many science teachers continue to rely heavily on textbooks and recitations, and now we have school districts that give bribes to teachers who improve their students' examination scores on "high-stakes" tests. Worse yet, several states have enacted college tuition breaks based exclusively on students' test scores. The result is that teachers spend their time "covering" the content of state tests and that students spend their time in school learning about science from textbooks that ignore their individual lives, and spend more and more time taking these tests that rarely go beyond measuring their recall of generic "facts" and concepts. Perhaps, such focus upon science facts and concepts may enable students to eventually contribute to the interests of an economically oriented society; however, this too represents a decorated landscape. As illuminated in the work of Jonathan Kozol (1985, 1992, 1996, 2005), poverty, funding issues, and unequal educational opportunities for minority students still are at the root of achievement gaps.

If we are going to move beyond the decorated landscapes of the current educational reform, we might try something more significant and appropriate. We claim that the landscapes of pluralism should be the main focus of a science education centered on preparing students to make informed choices and fully participate in society in ways that are reflective, reliant, and reciprocal of Earth's many natural environments that sustain life itself. The landscapes of pluralism represent cultures—gender, race, ethnicity, religious background, class, and socioeconomic status—and the diversity of ways in which humans come to know and express their voices (voices of the past, present, and future) as equal stakeholders in democratic life and in the Earth's natural environments: not constituents of one reality but of many equally important realities (Greene, 1993). Thus, we see democracy most aligned with a continuously evolving perspective that values the equal representation and freedom of people as full constituents from within a pluralistic praxis (Ladson-Billings, 2004, 2006a, 2006b; Potthoff et al., 2000; Roth & Barton, 2004; Thayer-Bacon, 2000, 2001, 2002). Earth's natural environments signify the many diverse bioregions or the ecosystems that are an integral part of our students' democratic lives (Bowers, 1993, 2001, 2004; Brandt, 2004; Roth & Barton, 2004; Smith, 2002a, 2002b, 2004; Wilson, 2002).

Ironically, hints of such landscapes can be perceived in recommendations in reform documents such as the National Science Education Standards (National Research Council, 1996) and the Project 2061's Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993). Unfortunately, however, updating these "principles and generalizations of science disciplines and calling them standards can no longer be considered a reform of science education" (Hurd, 2002, p. 5). What should be the character of science education has been argued throughout the history of the enterprise since the 18th century in the United States and for longer in other parts of the world (DeBoer, 1991).

To us, given the world in which we educate our students, it is imperative that we move deliberately toward the meaningful landscapes that contribute to our students' existence in theory, research, and practice, rather than reifying the existing failed decorated landscapes of educational reform. We believe that we ought to challenge the current educational reforms before future generations do not have the necessary Earth environments to sustain their lives. We will argue that an education for life itself must be reflective, reliant, and reciprocal of the Earth's natural environments in which lives are situated. Finally, we will integrate Earth's natural environments, culture, gender, community, and voices as authentic and meaningful landscapes in our pursuit of pluralism in science education and advocate a movement in the direction of embracing and valuing a science education with a multifarious shape and scope dependent on the locality of our schools.

IN PURSUIT OF PLURALISM IN SCIENCE EDUCATION

We think the zoo is an appropriate metaphor, since science teachers often refer to their classrooms as "zoos." In reality, classrooms can be metaphorically described as zoos because they indeed enclose many unique and complex lives. However, classrooms are much more liberating to students than what we might imagine for the black bear. As we begin to embrace the very different classrooms, the importance and value of culture begins to emerge. The authentic and meaningful landscapes of culture include gender, race, ethnicity, religious background, class, and socioeconomic status. We will discuss culture and gender, but do not wish to downplay the importance of the other pluralistic categories that constitute culture. Furthermore, we discuss students' voices, community, and natural environments which become evident only upon a deeper analysis of the decorated landscapes.

Landscapes of Cultures in Science Education

In education, the term pluralism is often qualified as *cultural pluralism* and has become the most widely used way of discussing *multiculturalism* in the Western world (Hodson, 1999, p. 776). Multiculturalism promotes diversity—learning to appreciate and value others' contributions and valuing cultural identities. However, even this valued principle of multiculturalism may not prevent the dominant culture from inadvertently imposing its dominant values and beliefs on others. In many ways, acknowledging the learners' unique cultural lives plays a significant role in the growth, development, and existence of our students. Jerome Bruner (1996) reminds us that

> ...education is not simply a technical business of well-managed information processing, nor even simply a matter of applying 'learning theories' to the classroom or using the results of subject-centered 'achievement' testing. It is a complex pursuit of fitting a culture to the needs of its members and of fitting its members and their ways of knowing to the needs of the culture. (p. 43)

As many researchers have concluded from studies done in the context of other non-Eurocentric cultures (Baker & Taylor, 1995; Jegede, 1997), the Western science curriculum enacted in various contexts around the world (and in many diverse contexts within the United States) has prompted a conflict of worldviews with ethical and political dimensions. To be successful in the Western science curriculum, students may have to deny the value of the ways of knowing and sense making developed in their own cultural milieu, thus running "the risk of being viewed as outsiders by their family and community" (Gallard, Viggiano, Graham, Steward, & Vigliano, 1998).

Having unconsciously accepted the school science worldview as the criterion to evaluate their own cultural knowledges, students reproduce the relation of domination between worldviews (Bourdieu, 1994). This kind of "decorated landscape" has long contaminated school science and indoctrinated and desensitized students. Indoctrination (or acculturation) is perpetuated by promoting the knowledge of the dominant culture without considering the knowledges developed by students within their local culture as viable and genuine (Désautels, Garrison, & Fleury, 1998). Thus, in the science education experience of many students, their cultural ways of knowing have been ignored or denigrated as the dominant ways of knowing decorate the landscape. The net effect of the socialization of these students into the Western scientific worldview is a form of cultural alienation that severs students from their native ethos. The formal education of many of these students will end with high school and they will return to live in their village, which may be a difficult and troubling experience both for them and for the community.

What a student knows is more proximal than distal (Vygotsky, 1970). Thus, science education could be viewed as an *inside-out* approach to understanding one's self in relation to the natural world, which logically starts with the students and their immediate surroundings (Aikenhead, 2002, 2006; Aikenhead & Jegede, 1999). A more humanistic perspective in school science naturally begins by acknowledging the students' cultures, engaging their self-identities, and renegotiating the traditional Western values and content of the curriculum (Aikenhead, 2006). Science education becomes more humane when we consider the wide range of ways that people have participated in science from outside of the traditional Western settings and integrate these practices as part of an acculturation of students into the communities in which they actually exist.

Unfortunately, in many schools today, science is taught from an "outside-in" approach, which starts with a broad, global Western perspective and the scientific method. But because science is human constructed knowledge about the natural world, it is not exclusive to the Western canon. Vine Deloria Jr. (1997) reminds us that Western science has for a long time misrepresented and excluded the contributions of indigenous peoples. In essence, scientific "facts" such as the way in which people entered the American continents or the ways in which humans interacted with the megafauna (both still very controversial) continue to decorate school science because the oral traditions of indigenous peoples have yet to be acknowledged as equally valid contributions to our understanding.

In *Science Education for a Pluralist Society*, Michael Reiss (1993) points out that *every* science is an ethnoscience and that too many children "have no idea of the extent and significance of the contributions made to science by non-Western cultures" (p. 13). Reiss argues that ". . . a scientist's *perceptions* of the natural world, as well as her interpretations, come through her senses, herself as a person and her culture. What is of significance for science education is that there can be no single, universal, acultural science" (p. 24). Examples abound in the field of ethnobotany, including indigenous knowledge of food crops and pharmaceuticals (Wolfson, 1993). In 1535, for instance, the Huron people showed French explorer Jacques Cartier how to make an infusion from the bark and leaves of the Eastern white cedar to treat the scurvy of his men. This information could have saved a million

European lives. Over the following 200 years, more than a million European sailors died from scurvy, a disease caused by a deficiency of vitamin C, until James Lind "discovered" another cure, in this case, another plant product, lemon juice (Simpson, 1995). Latex, for another example, is made from the sap of the rubber plant of South America. Native peoples found many uses of rubber, including drying the sap into bouncing balls that were used in games. Naturally, these examples become the focus of a science education that values and embraces cultural pluralism—ways in which many diverse peoples have contributed to our understanding of the natural world. Indeed, cultural awareness in school science is more likely to be authentic and practiced where populations of *long-dwelling peoples* are significant. For instance, in Canada's Northwest Territory, the provincial science curriculum acknowledges the importance of both traditional knowledge and the local environments (Snively, 1995).

The implication is that school science could benefit significantly by examining the unique local cultural milieus present in almost every place in the world, the not-so-distant landscapes that could contribute much to the blanket of exclusive standardized reforms. The relevant cultural knowledges of the past contribute equally as much to our students' lives as the knowledges of the present and emerging future. Although the examples we have cited are of indigenous contributions long excluded from mainstream science education, we do not wish to marginalize or exclude relevant contributions of others, as they are equally important. Nor do we wish to ignore issues associated with race, ethnicity, religious background, socioeconomic status, and class that are equally important constituents of culture. Given the space provided for this argument, we will discuss *gender* as one example of many pluralistic categories deemphasized in the decorated landscapes of educational reform.

Landscapes of Gender in Science Education

In any zoo or place where an organism is contained within a limited space, it will develop and grow only to a size appropriate and proportionate to its environment. Usually, the decorated landscapes do not provide an adequate substitute environment in which a wild organism can really thrive. For many zoos, the determining factor of whether the decorated landscape contributes to the existence of an animal is whether it can successfully reproduce within the constraints of the environment (Conniff, 1999). Thus, since reproduction is a necessary life skill for evolutionary success—involving the ability to pass on genes—a suitable environment must contain enough attributes of the natural environment in order to contribute to the growth, development, and reproductive success of the species.

In education, essential life skills of the human species have been and continue to be excluded in the decorated landscapes of schooling. The reproductive processes of society, namely the rearing of children, should be considered to belong to the educational realm, though typically they are not (Martin, 1982). Vocational education is clearly seen as a preparation for the productive processes in society; however, liberal education is not typically depicted as preparation for carrying out the reproductive processes. Thus, there is no ready definition available for this type of education, nor is it acknowledged to exist. Furthermore, girls and women themselves have long been excluded from the educational landscapes. This is especially true in the decorated landscapes that adorn science education (Belenky, Clinchy, Goldberger, & Tarule, 1997/1986; Brickhouse, 2001; Brickhouse & Potter, 2001; Goldberger, Tarule, Clinchy, & Belenky, 1996; Jacobs & Bleeker, 2004; Kleinman, 1998; Richmond, Howes, Kurth, & Hazelwood, 1998).

For a vivid example, Keller (1983) writes about the struggles that the geneticist Barbara McClintock had to endure throughout her life, especially as a young girl interested in science. Most noteworthy was McClintock's relational and aesthetic way of knowing in science. Her methods were often described as "unscientific" by many of her colleagues. Over the years, McClintock learned how to really *get-to-know* her corn plants. She went through the fields and meticulously studied the phenotypes of each individual plant. Her creative ability to step into the plant and look around goes beyond an exclusive emphasis on rationality in Western science. McClintock learned to trust and respect these insights. She had a deep understanding of every plant from little sprouts until the end of each growing season. She purposely grew only one crop per season so that she would have time to know each plant intimately.

Keller (1983) describes McClintock as a scientist who combined the "rules of scientific methodology with a generous admixture of intuition, aesthetics, and philosophical commitment" (p. 145). Although McClintock was honored with the Nobel Prize for her work in microbiology in 1993, her *relational* and *aesthetic* ways of knowing in science have yet to be recognized in the standards-based reforms. Keller further notes McClintock's "way of looking that is necessarily in part determined by some private perspective" (p. 150). The "high-stakes" tests fail to capture the private (and public) creative and intuitive aspects of participating in the natural sciences. The standardization of curricula do not allow for such personal endeavors which mask the Nobel Prize winning attributes that could otherwise be cultivated in science classrooms today. Worse yet, the reproductive processes of society have yet to be fully recognized as equally important in school science, albeit that is exactly what Hurd (2000) advocates in *Transforming Middle School Science Education* as does Howes (2002) in *Connecting Girls and Science*.

Acknowledging the landscapes of pluralism that include gender dimensions helps us to begin to move beyond the decorated landscapes of educational reform to a place where *all* students are able to participate fully in science education as human beings. However, acknowledging gender and cultural ways of knowing in science education is not enough. We must also embrace and value students' unique voices in ways that go beyond the received reforms such as through the arts (Eisner, 2002, 2005; Greene, 1993, 1995; Mueller, 2006; Mueller & Bentley, 2005). However, the decorated landscapes of educational reform have historically and continue to marginalize the importance of these expressions of human existence.

PLURALISM IN SCIENCE EDUCATION

We have argued that by embracing and valuing pluralism in science education, we acknowledge the landscapes of culture. In recognizing cultural pluralism, we now consider how they are manifested in our classrooms and how students are prepared to enter democratic life as full participants. However, this preparation has been eclipsed by such decorated landscapes as the national standards-based reform movement with its "high-stakes" tests that threaten to eliminate opportunities for teachers to enact curricula tailored to students' interests and needs. These decorated reforms ignore and undermine the considerable diversity of American education.

Renewing a Relational, Community Emphasis and the Future of "Science Literacy"

Many feminist scholars (Darling-Hammond, 1998; Greene, 1993, 1995; Noddings, 1999; Thayer-Bacon, 1996, 2000, 2001, 2002) are calling for the renewal of a *relational,*

community emphasis in schools. These scholars agree that school reform efforts are too narrowly focused on student achievement, uniform standards, governance, and accountability. They assert that any education that focuses on students' lives must start with the constructs of community. Because learners are embedded, embodied, and situated in gender and diverse cultural milieus, we must be inclusive and *continuously* aware of every perspective if we wish to fully embrace an education that serves pluralistic communities *always-in-the-making* (Greene, 1993; Thayer-Bacon, 1996, 2000, 2001). Thus, we might use Greene's (1995) notion of the *social imagination* to construct the possibilities of an education with a pluralistic praxis. Communities that are focused on their citizens require robust imaginations if they are to be always in the making.

Roth and Barton (2004) in *Rethinking Scientific Literacy* would agree and claim that science literacy is enacted as a community collective praxis or as "citizen science"—the ways in which we engage in everyday situations (pp. 157–179). They argue that "scientific literacy is a property of collective situations and characterizes interactions irreducible to characters of individuals" and that science is just one of many resources that people can use to make decisions that affect their everyday lives (p. 158). They discuss agency as a means by which individuals can gain control over their personal situations:

> Students come to enact knowledge and, with it, power; and they take new positions in the dynamic of margin and center, which has traditionally constructed them as lesser beings. That is, students develop increasing control over (increasing levels of agency in) their life world by participating in activities that are meaningful because they contribute to their community as a whole. (p. 158)

Roth and Barton are critical of the current reforms in science education, including society-focused reforms that do not consider pluralism in full. They point out that students should be legitimately engaged in the authentic activities of their communities. They provided many examples of curriculum projects that are focused on the students' place where they fully participate and make the informed choices necessary to sustain their natural environments. However, Roth and Barton may take too much away from the individual student. Thus, they are subject to the criticisms of ignoring individual differences. A better approach is Thayer-Bacon's (2000, 2002) *individuals-in-relation-to-others* which also embodies a relational, community praxis (public and private) to science literacy, yet does not downplay the importance of individuals.

The possibilities of authentic activities are endless in science education and are limited only by the given generalized sets or categories. Standards-based educational reform is not about endless possibilities, but instead about *narrowing* of curriculum to reflect *yesterday's* dominant Western values and beliefs (Hiebert, 1999). Worse yet, standards-based reforms may narrow the realities of an evolving and futuristic pluralism. Of course, while we do not live in the future, we must acknowledge and *care* for the existence of people in the future. We contradict ourselves if we acknowledge the advantages of pluralistic milieus, yet do not consider the best possible landscapes for people in the future. The significant danger of current standards-based reforms is that they are too *limited* by national agendas rather than guided by local community goals. As *local* students reproduce the dominant forms of knowledge over and over again, their ways of knowing inevitably become invisible.

Furthermore, standards-based reforms do little to contribute to the future success of students beyond what Bowers (1993, 2001, 2004) has described as the perpetuation of Western cultural metaphors responsible for deepening the ecological crisis through textbooks, teachers, and curriculum. Western cultural metaphors such as individuality, consumerism, progress, anthropocentrism, and economic growth are rarely, if ever, challenged in science

classrooms and may inadvertently serve as barriers to the kind of environmental stewardship advocated by Roth and Barton (2004). Essentially, Earth's many natural environments that sustain life appear as economic interests for plunder. Like Bowers, we believe that we could challenge the decorated landscapes before future generations do not have the necessary Earth's environments to sustain their lives.

AN EXPANDED NOTION OF PLURALISM IN SCIENCE EDUCATION

Zoos have several important benefits. They provide opportunities for people of all ages to experience and learn about animals that they would likely never see in the wild. Most zoos today educate the public about endangered species and the need to protect them. But zoos often fall short in other areas. By featuring large and spectacular animals in order to draw visitors, few zoos, for example, adequately display the native fauna and flora of their own geographic region. It is unfortunate to think that future generations might not have the chance to observe the now endangered and eventually extinct wildlife in zoos today if natural environments are not conserved (Wilson, 2002).

Currently, an education for the conservation of Earth's natural environments is treated as if it were completely separate from the mainstream science coursework required in schools, if embraced at all (Coyle, 2005). However, there has been a growing interest in *place-based education* as a method of teaching, redefining schooling, and conserving Earth's natural environments (Bowers, 2001, 2004; Gruenewald, 2003a, 2003b; Smith, 2002a, 2002b; Sobel, 2004). Place-based education emphasizes the places where students actually exist.

The nature of locally based education is continuously evolving and takes on different forms in rural and urban communities and because of the variety of both places and students. Bowers (2004) describes education for place as consonant with "eco-justice," a revitalization of the commons that

> ...strengthens the ability of the world's diverse cultures to resist the environmentally destructive and culturally homogenizing forces that are now being globalized. This alternate approach to educational reform involves learning about (indeed, revitalizing) the traditions of the commons of these cultures that go back to the origins of humankind. Basically, the commons included what was available to all members of the culture: the water, air, woodlands, pastures, plants, animals, as well as other natural systems. (p. 49)

We believe that place-based education is also consonant with the landscapes of pluralism (gender, multiculturalism, and the Earth's natural environments) in science education.

For a long time now, science teachers have had an array of curriculum resources representing the authentic and meaningful landscapes of pluralism to draw upon. However, because current education reforms are embedded in dominant Western values, classroom instruction may reify the existing decorated landscapes and undermine the purpose of science education if instruction is not directly centered on empowering the students to make decisions regarding their local Earth's environments. Thus, if not questioned, a significant danger of *place-based pedagogies* is that they may inadvertently reproduce the embedded Western values that denigrate the local place (Bowers, 1993, 2001, 2004). This issue is challenging to avoid because mandated reforms such as "high-stakes" tests do not provide the latitude needed to fully implement place-based pedagogies in science education. This is a pedagogical issue not only in the West but also particularly in the developing world where many countries depend upon imported Western curriculum materials.

Educational reform movements everywhere could benefit from the educational landscapes that are emerging in some developing countries, but for a long time now the decorated landscapes of Western influence have created a serious disconnect between science and students lives in many developing countries. However, the emerging work is promising to mediate the Western canon, an example being the new curriculum materials in Africa (Entsua-Mensah, 2001, 2004; Jegede, 1995, 1997; Kroma, 1995). This work embraces and values indigenous knowledge and the local Earth's environment as the basis of new curricula in science that are supportive of students' identities yet also endorse science as a way of knowing. Proponents of this work recognize that the received decorated landscapes of the West are not contributing to their children's existence.

Mediating the Western Canon in Ghanaian Science Education Reforms

In Ghana, an integrated, more culturally and ecologically responsive curriculum is currently being enacted in secondary science courses. *Science in Action* by Anamuah-Mensah, Savage, Quaye, and Towse (2005) was developed to enhance, support, and supplement the high school science curriculum. Components include a teacher's resource book and a workbook that contain activities designed to "assist students to develop survey instruments, write memos and proposals, plan and carry out projects, and work in teams. The objective . . . is to encourage students to see science in its relationship with the society, the economy and the environment" (p. v). This curriculum incorporates local knowledges and thus provides opportunities for Ghana's teachers to make science education relevant to the country's students. Students study science through games, word searches, crossword puzzles, case studies, role-play, debates, projects, and ecoprofiles.

For instance, Chapter 6.7 elicits students' participation in a community research project about paint (Anamuah-Mensah et al., 2005). Students must conduct a community research project using surveys and interviews to "learn about some factors affecting poor quality paints on the Ghanaian market" (p. 81). In addition, they work on several case studies identifying "the factors associated with low quality paints or even with poor application of higher quality paints" in an investigation of a claim made by local businesses protesting the use of paint products that fade and deteriorate soon after use (p. 83). In the end, students construct an ecoprofile that assesses the total effect of paint production on the "raw materials, energy, and the environment" (p. 85). Another example is the production of soap found in Chapter 19. Case studies help students to identify the "socio-economic issues related to the importation of soap into Ghana" (p. 196). These investigations provide opportunities for students to determine the quality and differences in soap, the environmental impact due to increased numbers of soap factories, and the cleansing power of soap. Projects include determining the contents of the effluent of a soap factory, designing and testing a system for treating effluent, and determining the efficiency of different detergents and soaps. Students also "devise ways of improving traditionally made soaps" (p. 204). Authentic projects such as these develop science literacy, reduce student alienation, empower learners to make informed decisions based on the conservation of some indigenous practices and their local Earth's environments, and integrate students as full participants in community life. However, schools need the freedoms necessary to work outside of the mandated reforms in order to legitimately implement these types of locally based projects. Projects such as this are starting to emerge in US schools that recognize the need to conserve Earth's natural environments.

Including Earth's Natural Environments in U.S. School Education Reforms

Brandt (2004) provides a 3-year description of her courses in ethnobiology at the University of New Mexico. In these courses, members of local nations of indigenous peoples and the students themselves shared the responsibility of co-instruction. Water and water rights were the central issues discussed including "government mismanagement of water resources" which deprived indigenous communities of activities that defined their cultural identity (p. 100). In addition, students participated in field trips, discussed papers, invited guest speakers, reviewed ethnobotanical literature and research, and explored other topics connected to the local context. Students wrote several papers reflecting on the local knowledges in the context of their lives including an "ethnobotanical autobiography" (p. 101).

Ecojustice topics remained at the forefront of instruction; students explored "the sociocultural, political, economic, and environmental relations enmeshed in a specific locale and the knowledge generated at a geographic location" (p. 101). For many students who embraced the Western scientific standpoint, this course was an opportunity to reexamine the "social and political context of academic science" (p. 102). Thus, this course became an opportunity for students to identify multiple contexts in which science knowledge is generated. For students, their personal experiences "using traditional medicine, in practicing farming or gardening, and in collecting plants for basketry or other material uses" became an essential part of what it means to be scientifically literate. For Brandt, ethnobiology became a way to teach ecojustice. "Using pedagogy of place and epistemic learning offers a new role for the university to create sustainable communities and engaged citizens" (p. 105). Brandt states that a "critical place-based education constitutes science in its most democratic form" (p. 97).

In another example, Smith (2004) portrays a public school called the Environmental Middle School (EMS) in Portland, OR (currently a K-8 school that has since been renamed the Sunnyside Environmental School). This school aims to prepare students to care and contribute to their society through community service and environmental responsibility. In 2000, the EMS was the only secondary school to receive the Oregon State Department of Education's "exemplary designation," but high test scores were not the school's goal (p. 74). Smith describes the values and commitment of the faculty who chose to work at the EMS because they did not have to "check" their ideals at the door: "They bring what they care about to their classrooms and draw their students into a circle of care predicated on their desire for loving interactions among people, social justice in the broader community, and connectedness to the place where they live" (p. 75).

At the EMS, students are placed in mixed-grade classrooms each with a teacher who enacts a 3-year revolving thematic curriculum consisting of "rivers, forests, and mountains" (p. 78). This schedule allows teachers to incorporate one day a week for "fieldwork or service learning" (p. 78). Often, the community and region become the context for learning at the EMS, such as through local projects involving the Willamette and Columbia rivers. Smith notes that teachers listen to their students and often incorporate student ideas. Teachers dialogue with their students about "the nature and costs of caring behaviors" (p. 82). Such conversations occur informally during travel time to field study locations. Students spend time in the field honing their science investigation skills and take time during their field experiences to reflect on what they have studied in the classroom.

Students at the EMS have many opportunities to practice caring behavior, such as through service learning projects, field studies, and academic experiences. Smith notes that students

are encouraged to participate in activities involving "social justice and ecological sustainability" (p. 83). Examples of student projects include

> ...tree planting, the construction of raised vegetable beds at a camp for homeless people, the development of a pocket park in a low-income neighborhood close to the school, serving lunch at a local soup kitchen, the removal of downspouts from homes and public buildings, student organized canned food drives, Operation Shoebox (a project that collects and then distributes school supplies and toiletries to children in Honduras), and the collection of blankets and towels for animals at a local shelter. (p. 83)

In addition, students had opportunities to care for each other at school, such as in preparing lunches and in a "reading-buddies program" (p. 84). Students at the EMS commented that they enjoyed getting to know other people better and in learning in real-world situations. Teachers commented that students had many opportunities to "practice caring for the nonhuman world" and developed a "deep regard for the land" (p. 84). The EMS is "predicated on the willingness to believe that, at base, young people are capable of care and choose to act in this way when encouraged to do so" (p. 88). It emphasizes each student's ability to contribute to the well-being of the community. At the end of the year, students create a portfolio of their annual accomplishments, and, during their final weeks, eighth graders present what they will be taking away from the EMS. Smith notes that students demonstrate their understanding and commitment to caring about the world through these final projects.

Place-based education may or may not be compatible with the current standards-based educational reform project (researchers have yet to reach a consensus on that). Researchers might help illuminate the short- and long-term outcomes of place-based education, determining whether or not this pedagogy cultivates student identity and affective development, more constructive thinking, and warranted understanding of the natural world. However, place-based education is a praxis that starts with the students and their environments and extends outward from the relationships that already exist and thus runs the risk of an exclusive study of the students' place without considering others' places as *relational*.

PROGRESSIVE REFORMS TOWARD THE LANDSCAPES OF PLURALISM

As embedded and situated human beings, it can be very difficult to see beyond the decorated landscapes. It can be even more difficult to think beyond today to the future. However, as the authentic and meaningful landscapes emerge, we begin by acknowledging the many categories of culture and recognize communities where students' unique voices are embraced and valued. These voices must be recognized if we expect our students to make informed decisions and participate fully as members of society. In addition, we must *reintegrate* educational projects within the curriculum that promote conservation of culture and of the Earth's natural environments, perhaps through ecojustice pedagogy (Bowers, 2001, 2004). We do this by acknowledging that between education that is culturally relevant and education for conserving the Earth's natural environments a relationship exists that is reflective, reliant, and reciprocal of culture. By embracing and valuing this relationship, we can engage students in scientific literacy where they are not ignorant consumers of their world but informed consumers of the science needed to participate in democratic life. This significant relationship provides many avenues for reform in science education that will move us beyond the current educational reforms and toward more authentic and meaningful reforms (considering all perspectives—people and their Earth's environments).

Education for Pluralistic Life

While there are many other decorated landscapes of educational reform that could be discussed, we believe that shifting science education toward embracing and valuing pluralism is a worthwhile pursuit and so very crucial to human existence. In contrast to the decorated landscapes of educational reform, we believe that all science education theory, research, and practice could consider an education for life situated in Earth's natural environments and "vice versa" in order to provide for our students an education more suited for the realities of life itself.

By combining these domains, we hope to initiate in science education an urgently needed authentic literacy of the natural world. By recognizing the unique voices of our students, we provide space and time for their existence, but in order to provide an education for their existence, we must fully embrace their past, present, *and* future voices. Voices of the past are recognized as conserved knowledges that help us make informed decisions in the present and future. Voices of the present are recognized because they help us critique and clarify our own experiences (thus, contrasting voices are particularly important because they remind us that we are situated/embedded beings and may not otherwise "see" beyond the decorations). And voices of the future are recognized because they are constituent of the social imagination in which the futures of pluralism thrive—always in the making.

The current mandated reforms tout "one-size-fits-all" mentalities. However, we now know that the authentic and meaningful landscapes of pluralism ensure lives which cannot be the same if they are to be unique reflections of the Earth's natural environments in which they are situated. Movements toward democratic life must be aligned with Earth's natural environments to guarantee future choices and participation of the people. Earth's natural environments depend on the informed choices and participation of the people, or they deteriorate. Thus, democracies and Earth's natural environments are reliant and reciprocal—they sustain each other: democracy is and will be a reflection, reliant, and reciprocal of the Earth's environment and the natural environment will be a reflection, reliant, and reciprocal of the democratic community itself. By considering both the meaningful purpose of democracy and for conserving the Earth's natural environments, we provide an open window for future generations.

So what should be the character of science education after 300 years of conversation in the United States and longer abroad? *Life* itself seems to be the meaningful purpose of a science literacy that will provide for students percipience far beyond the decorated landscapes of education reform. Thus, an education for pluralistic life must also be an education *of* pluralistic life (conserving life), which means that we cannot just teach this stuff, we must enact it both inside and outside our classrooms.

Implications for Future Theory, Research, and Practice in Science Education

As science educators, we might embrace an education *for* and *of* pluralistic life in terms of aligning theory, research, and practice. Teachers of science must take into account their students' culture (and gender), voices, community, and Earth's environments before planning and enacting curriculum. Science education is not simply an acculturation process (Brickhouse, 2001), nor is it our purpose as science educators to colonize student minds with the Western canon (Aikenhead, 2006; Garrison, Bentley, Fleury, Larochelle, & Desautels, 1999; Roth & Barton, 2004). Acculturation does not account for all the ways that students' value and aspire to do science. Embracing and valuing pluralism in science education means that students are not constrained as prisoners of their own autobiographies. Embracing

and valuing pluralism in science education means that as teachers we can move beyond educational reforms that do not contribute to pluralistic life.

An education to prepare students for life in a pluralistic society will include environmental stewardship and ought to be an integral part of every course offering in the natural sciences. Educators have a responsibility to the society of cultural and environmental conservation. We educators have an ethical responsibility to provide experiences that are both appropriate for our students and respectful to the Earth. Furthermore, we must encourage our students to question—as essential epistemic practice—the predominant Western views of economic growth and scientific and technological progress as always good for society (Bowers, 1993, 2001, 2004; Fleury & Bentley, 2000).

Such practice of science education may seem daunting, as class sizes continue to increase both in numbers and diversity. However, taking account of pluralism in science education *is* authentic assessment. Thus, our assessment practices should differ from current "high-stakes" testing because they do not rely on the assumptions of the decorated landscapes to ensure rigor. Rigor comes from the wide range (the more the better) of *authentic* evidences that can be compared and contrasted (Aikenhead, 2006). Perhaps, by acknowledging and recognizing the uniqueness of our students and their voices and their natural environments, we can engage in *action* (Roth & Barton, 2004) as well as in *action research* that will reveal the more authentic and relevant educational experiences and assessments most suited to our unique landscapes (Aikenhead, 2006; Atkin & Black, 2003).

As for teacher educators, we must practice and model "what we preach." Darling-Hammond (1998) notes that teachers who are "prepared for learner-centered and learning-centered practice" will embrace the notion of a holistic education through democratic communities that empower students (p. 90). She recommends that teachers be exposed to a variety of teaching strategies that will engage the diversity of students they will encounter in the public schools. As teacher educators, we should aim to prepare our preservice teachers so that they will be able to understand, embrace, and value their students' talents, aspirations, prior knowledges and different ways of knowing, and Earth's environments.

Educational researchers must also have pluralism in mind as they study science education through the many modes of scholarship available such as historical, quantitative and qualitative, and *philosophical* (often excluded) research paradigms that are equally valid contributions to our field (and we ought to consider other forms of research as they emerge in the future; cf. Aikenhead, 2006). However, researchers should remain skeptical of the view that all educational research represents progress.

Progressive reforms in science education, reforms toward the landscapes of pluralism, do not mean the elimination of standards (we contend that there have always been and that *there will always be standards*, though not necessarily appropriate ones). What will change, however, are *priorities*. Instead of prioritizing student preparation for annual standardized tests, science educators will prioritize students' preparation for citizenship (in-relation-to-other-citizens). This can begin by providing students opportunities in curricula for developmental epistemological practice (McKeown & Beck, 2004), such as through reflecting on their own autobiographies in relation to science (Bryan & Tippins, 2005), and can be manifest in projects of both *action* and *reaction*. Thus, as science educators, we acknowledge each student's unique existence by landscaping our pedagogies with authentic pluralism in mind. We contribute to our students existence by looking to their communities for both local values and indigenous knowledges, providing opportunities for them to engage in locally based projects, and integrating science with the cultural arts and performances that allow for aesthetic expressions of knowledge (Dewey, 1925/1971; Eisner, 2002, 2005; Gallenstein, 2005; Girod & Schepige, 2003; Greene, 1995; Mueller, 2006; Mueller & Bentley, 2005).

Ultimately, we enhance our students' quality of life so that they will grow and develop within their human and natural communities, and, in turn, benefit those communities.

CONCLUSION

Many times at zoos, visitors get away with inappropriate behavior toward confined animals—banging on the glass, yelling at them, and rattling the cages to provoke a response. Often food litter and cigarette butts find their way into the enclosures. Visitors can rarely observe animals behaving as they would in the wild or even see accurate replicas of the animals' natural habitats. Thus, a zoo exhibit could inadvertently cultivate disrespect and misconceptions. Some of this could be avoided with *appropriate* exhibit design, but for our purpose here, the zoo issues we describe reflect the reality of most zoos and amply illustrate the notion of a *decorated* landscape.

We began by questioning whether the decorated landscapes of educational reform contribute to our students' existence. We claimed that we should move deliberately toward pluralism in science education by acknowledging students' cultures (and many facets including gender), voices, communities, and natural environments as reflective, reliant, and reciprocal. We advocate a movement in the direction of embracing and valuing a science education with a multifarious shape and scope dependent on the locality (bioregion/ecosystem) in which our students live. We believe that an education focused on the existence of humankind is a much needed literacy and should be embraced as an overarching construct for science education.

We see science education as a process that is not a single path but "as an evolving map of ways to cope with the world" (Jegede, 1995, p. 165). By prioritizing an education *for* and *of* pluralistic life, science educators provide their students with opportunities for meaningful interactions that extend, not necessarily supplant, the established curricula. Furthermore, by prioritizing pluralism in science education, we will help correct some of the many misconceptions students hold about the shape and scope of science itself. Richmond et al. (1998) discuss this aspect of science education reform:

> To teach effectively is not to destroy the shape of scientific practice as it existed in the past, but to recognize factors that have created its shape and scope, as well as its limitations, to understand how it can be reshaped so that it invites in multiple perspectives and diverse groups of practitioners, and to reshape it along with one's students, who, in the process become empowered to critique, extract, and then, perhaps most important, go on to design their own ways of engaging in scientific investigation. (p. 916)

For now, the zoo's black bears can only dream about an environment where they can make choices and move freely. Of course, black bears raised in captivity, like our students, may not know any differently. Thus, as educators, we are challenged to move toward authentic and meaningful landscapes of pluralism in science education for our children, their futures, and as a way for our species to live in concert with the natural world.

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