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Living Soil and Sustainability Education: Linking Pedagogy and Pedology

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Abstract:

Sustainability is now permeating educational institutions. Yet the emerging discourse on sustainability education is in many ways caught in a modern web of theoretical, ontological, and epistemological assumptions that are incongruent with sustainability. We introduce an ecologically grounded metaphoric language rooted in *living soil* as an alternative regenerative framework for linking sustainability pedagogy with pedology (the study of soil). Five principles that guide this relationship are presented: valuing biocultural diversity, sensitizing our senses, recognizing place, cultivating interconnection, and embracing practical experience. Nurtured within an environment of curiosity, wonder, and questioning, and set to the rhythm and scale of localized ecologies, soil serves as an embodiment of life right beneath our feet rather than the reach of distant stars. In learning gardens, living soil and pedagogy surface in dynamic ways to create an ecological landscape of sustainability education.

Key Words: Living soil, ecological pedagogy, linking pedagogy and pedology, learning gardens

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To forget how to dig the earth and to tend the soil is to forget ourselves.

- Mohandas Gandhi

Without husbandry, “soil science” too easily ignores the community of creatures that live in and from, that make and are made by, the soil.

- Wendell Berry

I am as much a child of my native soil as I am of my mother and father.

- Wangaari Mathai

Sustainability education is now an emergent field of possibilities gathering hope toward a “climate of change” in education. Green school and university initiatives include sustainability offices and centers to address policy matters related to: building construction, transportation, energy usage, nutrition and health, recycling, waste reduction, among others. Sustainability indices are being developed and institutions are “ranked” based on their adherence to sustainability criteria addressing economic, environmental, and social issues.

However, amidst a generally positive atmosphere encompassing a wide range of vibrant multi-disciplinary sustainability interests, the authors sense that the fundamental assumptions guiding curriculum and pedagogy are left unaddressed. There remains a lingering tendency to continue to enshrine modernist ways of thinking. Partly this is achieved through repetition of dominant metaphors, as well as through carrying forward un- or under-examined cultural, epistemological and ontological assumptions that encourage piecemeal, rational and detached “objective” views of experience and the world (Bowers, 1997; Esteva & Prakash, 1998; Kumar, 2002; Sterling, 2001). It is inevitable that even the concept of “sustainability” would fall prey to the rules of opportunistic engagement (Sauvé, Berryman & Brunelle, 2007).

While the discourse on sustainability is a matter of concern, it also provides an opening for creative re-thinking. We believe that no monolithic meta-narrative of “sustainability” suffices in how our environmental and related social justice problems might be addressed. Rather, it is in the millions of diverse grass-roots efforts informed by place and culture, locale and community, hands and feet, heart and head, that the seeds of sustainability will likely sprout (Esteva & Prakash, 1998; Hawken, 2007; Shiva, 2008). For this, the milieu and context is soil.

But, one might ask, what does soil have to do with education? For us, *living soil* serves as a relevant entry point to engage the discourse on sustainability. First, we offer a critique of the modernist paradigm within which the sustainability discourse is situated. Next, a metaphoric discussion of living soil serves as a prelude to the five principles of sustainability education that we have developed with a view to link pedagogy and pedology, the study of soil. We argue that for sustainability education, we need an ecological foundation of learning for which living soil serves as a promising metaphor and guide.

Sustainability Education Discourse and Dominant Modern Worldviews

In the tradition of identifying schools as sites for social change, it has been suggested that education serve as a means for “learning our way” out of social and ecological crises and toward sustainability (Orr, 1992). Yet, much of the present discourse on sustainability education is reinforced by ecologically problematic aspects of the dominant modern worldviews (Bowers, 1997). To clarify this position, we have identified the following five areas of concern:

(a) *Homogenization of curriculum and learning*: At present, the homogenization of curriculum emphasizes the industrial quality of schools in which the critical importance of context is erased. The production and transmission of knowledge is divided spatially, socially and temporally from society and removed from the local human and biotic communities in which schools physically exist (Gruenewald & Smith, 2008). Racing to the top on the road to progress, children's latent creativity, curiosity and wonder are paved through the explicit standardization and uniformity of curriculum and learning methodologies with a view toward ever more efficient use of human, informational, and intellectual "resources."

(b) *Privileging of the head*: Modern educational systems divorce knowledge from lived experience and affective dimensions of life. The dichotomies characteristic of the modernistic Cartesian paradigm are carried forward in sets of binaries germane to education such as right-wrong, teacher-student, and teaching-learning. These separations promote oppositional arrangements that privilege the teacher as all-knowing and position the student as a passive receiver of transmitted knowledge. A central dichotomy separates head from hands, mind from matter, and ideas from experience (Sipos, Battisti & Grimm, 2008; Sterling, 2001).

(c) *De-contextualization of knowledge*: An increasing division of knowledge into fields of specialization continues to characterize modern educational systems, contributing to an intellectual myopia that cripples the ability of the educated who cannot "see the forest for the trees." The intricate web of relations (Capra, 1996) to which the tree is bound is obscured by the "silo-ing" (Orr, 1992) tendency of the academy. Within this view knowledge retains little relationship to the social and ecological context from which it arises and in which it must be ultimately applied. Responsible application of knowledge—that is, considering potential ecological consequences of actions—is overlooked in such a de-contextualized transmission of "neutral" knowledge (Capra, 1996; Orr, 1992).

(d) *Honoring of the autonomous individual*: A number of European Enlightenment ideas such as Descartes' declaration of independence, "*cogito, ergo sum*," or "I think, therefore I am," Charles Darwin's theory of evolution, which cast the individual as the basic ecological unit and the natural world as a battleground for scarce resources, and Adam Smith's notion of the "invisible hand" guiding capitalist economics through rational self-interest (Esteva & Prakash, 1998) deepen an ontological division of mind from matter and culture from nature, and emphasize an individualist outlook on existence (Kumar, 2002). In terms of educational practice, an honoring of the autonomous individual at the expense of community interconnectedness encourages a competitive approach to achievement (e.g. Race to the Top) even when couched in terms of collective movement (e.g. No Child Left Behind).

(e) *Valuing of abstract ideas*: Within modernistic educational systems, there is a clear delineation of status ascribed to knowledge. High-status knowledge is abstract, theoretical, scientific, and de-contextualized from the physical world. Low-status knowledge is associated with manual, craft, or trade knowledge, and has typically been limited to high school vocational training and community colleges (Bowers, 2000). An inequitable pattern of funding provided for techno-scientific research while humanities budgets are reduced demonstrates a division of values in monetary terms. One of the dangers of privileging high-status abstract knowledge at the expense of practical place-based knowledge relates to devaluing forms of cultural capital encoded in oral traditions and marginalizing face-to-face, recursive, iterative, experiential, temporal, spontaneous, and long-term teaching and learning relationships embedded in local cultures and ecologies (Cajete, 2001; Smith & Williams, 1999).

Taken together, these five aspects of the modernist orientation—homogenization of curricula and learning, privileging of the head, de-contextualization of knowledge, honoring of the autonomous individual and valuing of abstract ideas—are incongruent with sustainability. Contextualized understandings and holistic relationships among tangible living entities are the hallmark of sustainability (Capra, 1996), thus an alternative paradigmatic framework that is more ecologically grounded is needed. For us, soil serves as an animate option.

Living Soil as an Ecological Lens for Organizing Sustainability Pedagogy

In moving the emergent sustainability education discourse beyond the trappings of the modernistic metaphors and worldviews described above, we propose the development of a regenerative metaphorical language to inform sustainability teaching and learning. Both of us have initiated and cultivated school learning gardens, which offer a promising avenue and entry point toward engaging students of all ages in learning about sustainability in a hands-on practical manner. Through our mutual and individual experiences with learning gardens, we have found *living soil* to be a potent metaphorical lens through which to begin a formulation of ecologically grounded principles for sustainability education. We recognize that this framework is somewhat limited as it is explicitly terrestrial. Nor do we claim to be soil experts. However restricted, our intention is to begin an iterative process to encourage exploration of ecologically grounded phenomena such as soil as the theoretical basis for sustainability education, rather than recycling inflexible mechanistic metaphors and their corresponding cultural assumptions.

What is Living Soil and Why is it Important?

Given the burgeoning urban population worldwide, soil is often out of sight out of mind. Children, particularly urban children, grow up more with a sense of grey roads paved with asphalt and concrete than with “dirt” roads of exposed soil (Louv, 2008). Tar, rather than soil, is the smell they are more likely to decipher. Paved realities of sealed and impervious soil will likely alter the human experience and psyche in deep ways. This is particularly disturbing, since soil pulsates with life; it is the living skin of the earth (Logan, 1996). Unlocking the mysteries of soil helps us to unlock the secrets of sustainable life. Instead of looking for life upward among the celestial stars, we suggest paying attention downward to life beneath our feet.



Figure 1: Handful of living soil (photo credit D. Williams)

Soil is also intimately connected to culture, as is the history of soil with the history of humanity¹ (Hyams, 1976; Montgomery, 2007). Human beings have had a spiritual, cultural, and sensual relationship and attachment to soil (Kumar, 2002; Shiva, 2008). Diverse spiritual teachings remind us that we arise from the soil and to the soil we eventually return: whether it is the Hindu Vedas or the Christian Bible, soil serves as reference point for teaching about the sacredness of life, for our daily bread reaches us not by providence but through the nurturing interactions of soil and people.

Soil is more than a mere growing medium. It is a unique confluence that includes eroding rock, decomposing biomass, microorganisms, animals, insects, water, and air. It is layered, develops over time, is fragile yet resilient, and contains and supports life.



Figure 2: Student mural of soil life (photo credit D. Williams)

Even when taken together, though, these aspects omit a critical element of soil: that it is itself living. We already know that soils are heaving with myriads of digestive systems, nervous systems, skeletal systems: a web of relationships. When we are able to get to know a particular soil, as in a garden of long tenure or a home bioregion, we often discover that soils can even have (at risk of anthropomorphizing and for lack of a better word) “personalities.” Through protracted contact with living soil we have each come to learn that successful interaction depends in large part upon healthy relationship with the soil, a factor that is overlooked in a merely biophysical/chemical description. Viewing soil as a living entity also invites us into kinship. Knowing that at its most basic function soil is living and that it promotes life encourages us to ask the question: how can we help? And, a related question is: where can we let it simply *be*?

It is of utmost importance that we seek to regain a tangible understanding of soil and create favorable conditions for students to engage with and be engaged by living soil. Through our involvement with school learning gardens we have observed the possibilities of creating fertile grounds for sustainability education. Here, we seek to translate our mutual passion for

¹ Terms such as *earth* and *ground*--while some of the oldest in human language--are etymologically related to *soil*.

literal living soil into a theoretical framework of ecological principles for sustainability education in general. Below we outline a number of principles that link pedagogy with pedology in hopes that living soil surfaces in the discourse on sustainability even as we create conditions for its fertility in education.

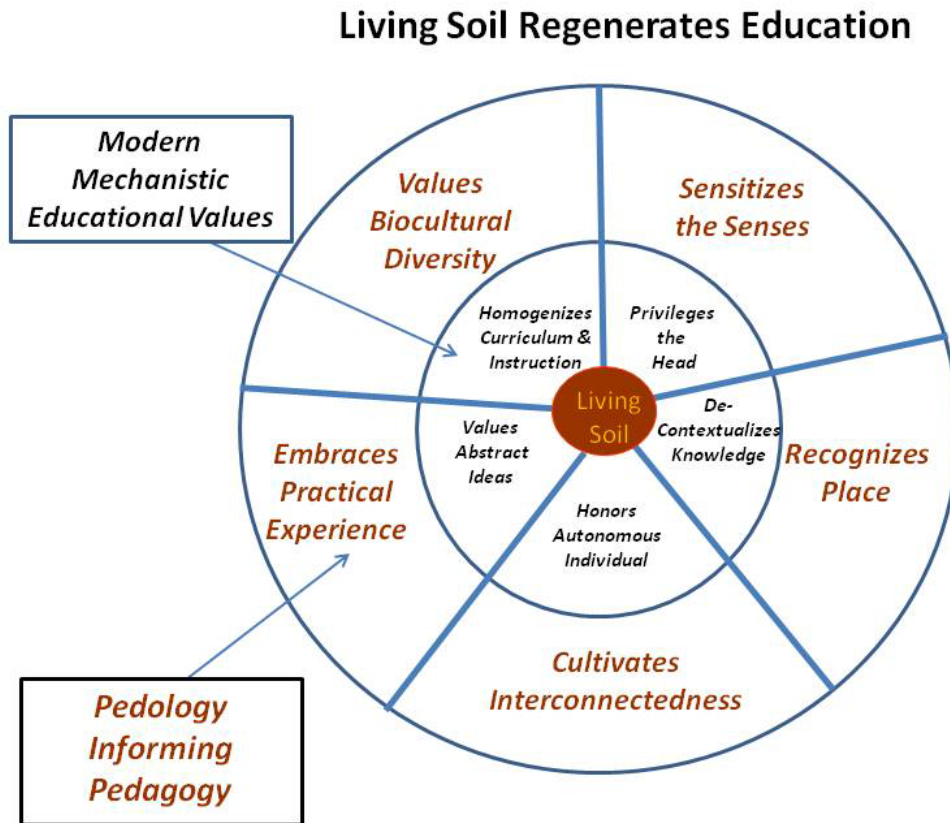


Figure 3: Principles Linking Pedagogy and Pedology

Principles that Link Pedagogy to Pedology

1. Valuing Biocultural Diversity

Soil teaches us that diversity is the essence of life. A single handful of living soil contains many organisms including bacteria, fungi, protozoa, nematodes, arthropods, and all sorts of decaying biomass. Many of the organisms are a mystery and as of yet unknown to scientists. In this light, intriguing questions emerge: How much life is right this moment occurring underneath our feet each day of which we are woefully unaware? How many unknown microorganisms do we disrupt with each step forward, not to mention through industrial activities such as excavation, field plowing, and bulldozing? E.O. Wilson (1994) and others (Kellert, 2005; Maffi, 2007) have raised awareness of threats to biological diversity and have pointed out that due to the rate of encroachment by development many species will be lost before they are even found. Accompanying the reduction of biological diversity is a parallel diminishment of cultural diversity as indigenous peoples are assimilated (often forcibly) into dominant mainstream

cultures. As in ecosystem dynamics, often the loss of cultural diversity can trigger a cascading loss of biological diversity, as when medicinal plants known only orally are uprooted as weeds in the wake of language assimilation (Maffi, 2007). Because the dominant language often lacks terms for certain endemic plants or experiences, the loss of language can be as devastating to ecosystems as the intrusion of the bulldozer. With this in mind, the question becomes: how can reverence for soil act as a pathway toward better understanding and balancing biocultural diversity?

Throughout history, soils have defined human societies (Landa & Feller, 2010). Soils are not merely physical places; they are also places of consciousness for indigenous communities (Cajete, 2001, p. 623). Soil diversity is based on climate, related flora and fauna, and human interactions; conversely, soil fertility defines human populations and their food sources. Colors, textures, porosity, inorganic and organic elements of soils result from and interact with the diversity of human cultures. Agrobiodiversity is as much about agricultural and biological diversity as it is about soil and cultural diversity. As Parajuli (2001, p. 584) observes: “naturally diverse regions are also culturally diverse.” To this we add, culture also plays a significant role in enhancing the diversity of pedons (units of soil). Soil diversity and human diversity co-evolve in their interaction with particular places. In order to conserve soil diversity and life, it is therefore imperative to conserve cultural diversity.

Sustainability education, then, must teach about and be embedded in honoring diversity—particularly soil, linguistic and biocultural diversity. As Maffi (2007) explains: Biocultural diversity comprises the diversity of life in all of its manifestations: biological, cultural, and linguistic, which are interrelated (and possibly co-evolved) within a complex socio-ecological adaptive system. ...The diversity of life is made up not only of the diversity of plants and animal species, habitats, and ecosystems found on the planet, but also of the diversity of human cultures and languages (p. 269).

These diversities interact with and affect one another in complex ways; they do not exist in separate and parallel realms, explains Maffi (2007). Furthermore, according to her, it is through mutual adaptation between the environment and humans at the local level—defined by place—that the links among these diversities have developed in a co-evolutionary manner. Living soil, being key to land’s memory and cultural memory, must also be counted in the equation of diversity as value since culture, agriculture, and cultivating the land are all connected in significant ways. Diversity is not only a value of life, it is life.

As a starting point, we offer our earlier articulated understanding of soil as more than merely biological, but as a living entity and macro-context for a diverse human-biotic community. Within this view a teaspoon of soil holds in equal measure cultural memory as biological diversity. Homogenization of human cultures, then, also inevitably results in the biotic homogenization of soil. As a corollary, homogenization of soil leads to the homogenization of cultures. These twin phenomena can be seen in the relentless progression toward fewer and fewer cultivars of major staple crops, such as wheat, rice and corn as well as in the narrowing of the modern diet (Nabhan, 2002). Those varieties best suited to unique soil, climate and cultural conditions have now been or are being subsumed by the corporatization and homogenization of agriculture (Shiva, 1993). We need to learn humility to realize that there is no “technological substitute” for soil (Shiva, 2008).

Beyond the norms of standardization, sustainability requires the flourishing of differences in children and young adults. Engaging children in soil tillage brings them into close contact with

biocultural diversity. Often in our experiences in learning gardens we have heard the outpouring of stories relating cultural experiences with soil, food, and place (Anderson, 2009), and have also witnessed students engaging with living soil as a dynamic entity.

Through the growing of food, soil becomes an active interlocutor between culture and ecology (Anderson, 2009; Klindienst, 2007). It is hard to know where one stops and the other begins: they are intertwined like the tendrils of pole beans climbing upon corn in a traditional Three Sisters garden. We can observe and learn from hopeful couplings of culture and ecology, as in the examples of many indigenous communities who found and maintained satisfactory ecological balance points, often mediated by cultural understandings of interconnection and responsible membership in the local soil community (Gadgil & Guha, 1992). For instance, the traditional practice of interplanting corn, squash and beans—known as the Three Sisters—ensures sufficient soil fertility for growing healthy corn. In a Three Sisters garden, sister bean fixes atmospheric nitrogen into the soil, which feeds sister corn, which supports climbing bean, while sister squash sprawls over the soil and acts as a living mulch to hold in soil moisture for all. In fields grown to corn alone, nitrogen is quickly exhausted, and must be subsequently imported in the form of manure, or, today, synthetic ammonia. The Three Sisters garden provides a model of ecologically mindful interplanting that is healthful for both planet and people: soil fertility and complete nutrition are parallel harvests. Within the framework of pedology, then, is the necessity to link human culture to living soil. Such a conception of humanity as part of the soil community—not apart from it—holds promise for moving toward sustainability pedagogy.

2. Sensitizing All Our Senses

“You feel it, hear it, touch it. Instead of looking at a book, you actually work and try to plant a plant.”

- Student, Learning Gardens

Soil is the stuff of life. Young children have a proclivity for eating soil, and despite their parents’ worries they are probably pursuing just the right nourishment. Long before university extension services, traditional and indigenous farmers were able to categorize many different types of soils based on sensory analysis, of which taste was one way of knowing. Within the modern framework, it is now all too common to *sanitize* our senses, especially within schools, where fear of disease is often present. Furthermore, schools are sanitized from the vagaries of society through geographical, temporal and spatial distancing from community life. Many students of all ages often comment that school is not “the real world,” and indeed they may be offering the simple observation that schools are in fact separated from “reality.” How might reverence for living soil help to ground schools and encourage sensitizing of the senses?

Sensuous in its appeal, soil draws sight, touch, smell, and taste into its fold in mesmerizing ways. When two skins--that of the earth and that of humans—come in contact, it is almost as though the pores and the capillaries exchange information. We see children delight in exploring the worms in soil. Thousands of tiny creatures, endlessly on the move, offer a plethora of stimuli of colors, shapes, textures, movements, wriggles, and busyness. Deciphering soil’s content can be magical and puzzling all at once.

According to David Abram (1996):

A genuinely ecological approach does not work to attain a mentally envisioned future, but strives to enter, ever more deeply, into the sensorial present. It strives to become ever more awake to the other lives, the other forms of sentience and sensibility that surround us in the open field of the present moment (p. 272).

Likewise, ecopsychologist Laura Sewell (1995), concerned about modern cultural conditioning and psychic numbing argues for “re-awakening our senses and intentionally honoring subjective experience” explaining that we must teach children to “return to our essential, animal selves, the selves that evolved in relation to the non-human natural world. In particular, our sensory systems are exquisitely evolved channels for translating between ‘in-here’ and ‘out-there’” (p. 203). Teaching children to attend with their senses is essential to developing connection to a place. We have found that in school gardens, encouraging children to sit quietly at their “secret spots” (Young, 2001) helps them learn to pay attention, to be mindful, to observe intently, to understand seasons, to marvel, to wonder, to listen with care, and to breathe. These secret spots often become sacred. As Wilson (1994) states, in the making of a naturalist citizen, it is “better to be an untutored savage for a while, not to know the names or anatomical details. Better to spend long stretches of time just searching and dreaming” (pp. 11-12).

3. Recognizing Place

“It's like I'm a member. I'm home. I'm safe. I'm comfortable.”

- Student, Learning Gardens

Sustainability education of any form or by any name should be connected to place, since one can no more teach sustainability out of context than one can take the context out of sustainability. As Wendell Berry reminds us, without a sense of place, humans, “can't know who they are because they don't know where they are.” Often, it is through direct experience and investigation of the flora and fauna, the soils, the seasons, the rhythms of the natural cycles, the histories, and the communities within which humans live, that we develop this sense. It is also in dialogue with place that “personhood and pedagogy” are intricately linked (Orr, 1992, pp.125-126).

According to Gary Snyder (1990), “the small lessons, the enormous lessons, the lessons that may be crucial to the planet's persistence” are learned in interaction with place (p. 26). He urges that we intimately reacquaint ourselves with place, since recollecting that we once lived in places is part of our contemporary rediscovery. “To know the spirit of the place is to realize that you are a part of a part and that the whole is made of parts, each of which is whole. You start with the part you are whole in,” Snyder explains (p. 38). Place, in other words, has fluidity: “The childhood landscape is learned on foot, and a map is inscribed in the mind...” (Snyder, 1990, pp. 26-27).

Like Snyder, for Berry (1991), place must be experienced to be known; however, commitment to place arises from deep knowledge of its intricacies, as he writes:

No place is to be learned like a textbook or a course in a school, and then turned away from forever on the assumption that one's knowledge is complete. What is to be known about it is without limit, and it is endlessly changing. Knowing it is therefore like breathing: it can happen, it stays real, only on the condition that it continue to happen (p. 75).

How might educational pedagogy informed by living soil respond? It is critical that place-based relationships be founded in the depths of geographical, historical, seasonal, ecological, and cultural understandings of place. This necessitates knowing the landscape as well as the soilscape over time. It requires an awakening and sensitizing of the senses to the defining features of the place where nature and culture, humans and non-humans, all become subjects of interest as stories emerge with the intimate understanding of places and their distinctive

communities. To wonder upon place and to dwell in it would guide sustainability education where philosophy and history, nature-writing and pedology merge in their explanatory intent.

For David Sobel (2004), place is about scale: “small, manageable” (p. 7). Place-based education has been successful in helping students understand their connection to both their communities and to the natural world (Gruenwald and Smith, 2008; Smith and Sobel, 2010).

The history, folk culture, social problems, economics, and aesthetics of the community and its environment are all on the agenda. In fact one of the core objectives is to look at how landscape, community infrastructure, watersheds, and cultural traditions all interact and shape each other (Sobel, 2004, p.9).

Chawla (2006) also reflects upon the value of what is gained from the personal relationships and the emotional attachment to a place—one created through experience. Beyond the four walls of the school:

[A person] encounters a dynamic, dense, multi-sensory flow of diversely structured information, but some places are richer in this regard than others. For example, shoppers are bombarded by more smells, sounds, and sights in a traditional marketplace than in a supermarket, and there is more information in a woodlot than a parking lot. In contrast...when others tell about the world second-hand through a text or an image, information is radically reduced – literally, in most cases, two-dimensional (Chawla, 2006, p. 67).

Living soil nurtures a vibrant biotic community endemic to a specific place. Since soil is locally relevant everywhere and unique in its diversity, we can root locally relevant sustainability pedagogy in pedology. In many communities, soil is buried beneath concrete and out of sight. In this way, soil is representative of the myriad peoples, histories, perspectives, etc., that have similarly been buried beneath the physical and metaphysical infrastructure of modernity. Investigating the local soil, both literally and figuratively, can be a way to begin a slow process of unearthing hidden or forgotten community history. This ecologically grounded suggestion parallels Freire’s (1970) “reading the world” as an integrative context in processes of unveiling social oppression. Agyeman’s (2005) work on “just sustainability” surfaces the intersection between economic and ecological justice. Gruenwald (2003), too, has proposed a “critical pedagogy of place.” Hence, in depth investigation of neighborhoods or busy streets and particularly community and school gardens (which have seen an enormous surge in recent years) may prove equally promising as an interdisciplinary study of cultural ecological phenomena.

In school garden projects we find one way to bring soil directly into educational processes as the basis of an ecologically sustainable and socially relevant interdisciplinary curriculum. One example is the “Common Roots” project, situated in northeastern Vermont, which addresses interrelated problems of community food security and land stewardship through encouraging intergenerational and multicultural learning, with the garden as the focal point of all investigation (Kiefer & Kemple, 1998). A central question that guides this project is simply “what has happened on this piece of land?” From this, further questions emerge such as “where are we,” “who are we,” and “where are we going?”

We recognize that in many locations, school gardens or visits to local farms may not be possible due to lack of arable land, lack of time, or polluted soil. One solution to these problems can be found in worm bins, which are low-cost, easy to build, and offer one way to begin food scrap recycling inside schools, an activity that simultaneously closes the nutrient loop by recycling wasted food and provides an integrative context for thinking about invertebrate life,

nutrient cycles, temperature, moisture, or waste as food (along with critical thinking about hunger). Worm bins demonstrate our human potential to aid in the production of soil.

4. Cultivating Interconnectedness

Engagement with living soil in school learning gardens is one practical way to introduce students to the idea of interconnectedness.



Figure 4: Interconnectedness (photo credit D. Williams)

Living soil is composed of a web of relationships among microorganisms, small animals, living and dying plants, tree roots, mycorrhizal bacteria, etc. Humans are also a critical member of the soil community (Hyams, 1976). We not only harvest from the soil but contribute to its sustenance or depravity through our actions. We are interconnected with soil in an endless dance—the key is to recognize this hidden connection. Highlighting the primacy of interconnection reflects a basic principle of ecological systems: “to *be* is to be related, for relationship is the essence of existence” (Swimme & Berry, 1992, p. 77). As an important component of sustainability pedagogy such a focus counters the dominant educational and social push toward individualism and disconnection (Smith & Williams, 1999), and invites students to be part of a greater whole.

Systems theories consistently present the idea of patterns of relationships (Capra, 1996): The sustainability of individual populations and the sustainability of the entire ecosystem are interdependent. No individual organism can exist in isolation. Animals depend on the photosynthesis of plants for their energy needs; plants depend on carbon dioxide produced by animals and on the nitrogen fixed bacteria at their roots. Together, plants, animals, and microorganisms regulate the entire biosphere and maintain the conditions conducive to life (p. 24).

In diversified ecosystems, interconnection between the parts encourages resiliency as a response to unexpected changes which are the nature of complex systems (Capra, 1996). Polycultural plantings, also known as “guilds,” intentionally combine one or more symbiotic plants in an attempt to mimic the interconnectedness of natural systems. Cultivating interconnection through sustainability pedagogy can involve planting a “guild” of ideas through bringing a plurality of perspectives to the table for collaborative exploration of a common question or problem. The establishment of university partnerships with indigenous communities,

the development of practical skills in school learning gardens, the introduction of alternative lifeways through intercultural and intergenerational learning (Smith and Williams, 1999), and the grounding of education in diverse human and natural ecologies (Gruenewald & Smith, 2008), are positive examples from practice that embrace interdependence as foundational to sustainability education. As John Muir (1911) observed: “When we try to pick out anything by itself, we find it hitched to everything else in the universe” (p. 326). Soil serves as a humble reminder of this truism.

Cognizant of our responsibility to sustain living soil, Kumar (2002) points out that care of soil is interrelated to care of self and society. The interconnection between soil, self and society is widely obscured by the conveniences of modern society. Learning gardens offer a venue for re-discovering these hidden linkages. For this, interdependence can serve as a guide (Capra, 1996):

All members of an ecological community are interconnected in a vast and intricate network of relationships, the web of life. They derive their essential properties, and in fact, their very existence from their relationships to other things. Interdependence—the mutual dependence of all life processes on one another—is the nature of all ecological relationships....Understanding ecological interdependence ...requires the shifts of perception that are characteristic of systems thinking—from parts to the whole, from objects to relationships, from contents to patterns (p. 298).

One of the profound lessons that we learn from nature is that a sustainable human community interacts with other communities—human and nonhuman—in ways that enable them to live and develop according to their nature. Sustainability, thus, is a dynamic process of co-evolution rather than a static state (Capra, 1996).

Soil can help us uncover our connected selves: our links with the natural world of which we are a part, our intergenerational relationships that provide us with historical understandings, our shared experiences with both the human and more-than-human worlds, and our relationships with the landscape, among others. To gauge these connections requires both humility and reverence. In such a view, life did not take over the planet through combat but through networking and partnerships. Learning gardens provide grounds for such understanding in cultivating Vaclav Havel’s (2000) observation: education is the ability to perceive the hidden connections between phenomena.

5. Embracing Practical Experience

“I get to work the soil and plant. It's hands-on instead of talking about it, I get to dig and get messy. That's my favorite thing.”

- Student, Learning Gardens

There is significant evidence to suggest that the experiences associated with unstructured activity and play in a natural setting positively influence environmental behaviors and beliefs later in life (Chawla, 2006; Kellert, 2005; Louv, 2008). These practical experiences with nature help children to create bonds that are meaningful over time.

Children today too often confront a contrived, artificial nature in place of an actual, ordinary experience. Confronting nature as fantasy creatures in story and film or as herds of exotic wildlife on television may be entertaining and sometimes instructive, but it can never adequately substitute for direct and real contact. The contrived experience of nature rarely provokes in children strong and lasting emotional responses, such as wonder, joy, surprise, challenge, and discovery (Kellert, 2005, p.74).

It may be argued that practical experience *in situ* with local soils is necessary for human cultures at large to develop sustainable land-use practices (Hyams, 1976). Learning by doing in place and over time is critical for nurturing an ecological balance between human cultures and biotic communities. A challenge here is the degree to which living soil has been eliminated from the modern landscape. While soil and natural areas were once commonplace to childhood, a number of ecological and social factors now keep many children apart from the natural world (Louv, 2008). Even in school learning gardens, often soil must be imported from elsewhere in order to alleviate omnipresent fear of latent toxicity in local soil. Though soil contact is made possible in this way, an integral element of stewardship is left out of the equation: what responsibility do we have to our native soils? Why should we care? Practical experience brings such difficult questions to the surface, and reminds us of the importance of thoughtful inquiry, curiosity, wonder and critical thinking within a framework of sustainability education.

Why is it that students stop asking questions and forget to wonder as they progress in school, when research points to curiosity and wonder as motivating factors that interest children to construct meaning about different things? Or, as Postman (1994) asks, why do children enter school as a question mark and leave as a period?

Sustainability education is about dealing with uncertainty. Neurophysiological theory suggests that curiosity is a state of arousal due to complex stimuli and uncertainty which lead to exploratory behavior (Berlyne, 1960). Stimulus variables such as unfamiliarity, novelty, complexity, ambiguity and incongruity may increase arousal level and induce curiosity. For exploratory behaviors, place, locale, community, and soil provide a rich milieu. Children's curiosity and wonder are often manifested in asking questions (Doris, 1991; Driscoll & Lownds, 2007), which is a link between thinking and learning. The generation of questions is a key component in the cognitive process that contributes to certain aspects of learning. When they question, students are thinking, seeking meaning, and connecting new ideas to familiar concepts. Questions are the language of wonder (Commeyras, 1995). It is the state of mind of wondering that leads to an experience of awe and sets into motion the search for responses (Opdal, 2001).

Our educational system and classrooms profess a fact-driven curriculum rather than curiosity-based and wonder-permitting learning environment. Standardization and test-taking force children into the "correct" way – the "getting it right" syndrome, instead of permitting students to explore the unknown (Latham, 1996). Countering this trend, while not easy, the role of the sustainability educator is to provide inquiry opportunities for students by making connections with their place, locale, and the natural world.

Even within the modern city, it remains possible to create and nurture meaningful practical interactions and critical inquiry with living soil in place. For example, activities such as de-paving unused school parking lots offer a hopeful glimpse into potential restorative relationship between human culture and soil, and ask us to critically consider the social norm of paving soil as a sign of progress. The living soil is abundant with fertile "seeds of change" even in the most dilapidated of environments. Plants growing through the concrete of cities are given assistance by children and community members motivated to uncover the earth. We can take a cue from the liberation of soil from tar and seek to liberate our pedagogy from the constraints of outmoded mechanistic language and industrial perspectives, encouraging the latent curiosity and wonder of children through practical engagement with living soil.

Finally, in articulating living soil as an ecologically grounded framework for sustainability education pedagogy, it is necessary to say a few words about rhythm and scale. We

are transitioning from the age of “enlightenment” toward what Kumar (2002) has termed the “age of ecology.” Moving away from the modernistic paradigm means in part re-calibrating our sense of time and space.

Much of modernistic education is set in lock step to a rigid clock: hours of learning are regulated by the bell, and years of mental, physical, and emotional development are charted in linear stage models. Living soil does not follow the linear progression of a mechanical clock. The seasons, winds and rains and pathways of the sun and moon set a rhythm that is beyond the regularity of the clock. Soil’s life is fluid and enduring. This rhythm is less “chronic” and more “kairoitic;” less time bound and more timely, less timed and more time-generous (Hawkins, 2010). We need a more nuanced ecological model rooted in the timeliness and timelessness of living soil that links the rhythm of pedology to the practice of pedagogy.

A second component of the modernistic paradigm that we aim to reframe in terms of living soil is scale. For too long the dominant trend in modern western culture has been a tendency to “think big” (Berry, 1970). This proclivity towards grandiosity continues to influence the emerging sustainability paradigm, as represented by vast wind farms and solar parks. Such a broad brush fails to interact in a responsible way with myriad diverse human and biotic communities, and thereby continues a pattern of oblivious large-scale top-down action. Thinking big often turns out to be not thinking wisely at all.

As the social and ecological problems of our time become increasingly complex, the solutions remain embarrassingly simple. Working with localized living soil reminds us that there is no such thing as a quick-fix or catch-all solution. After the promise of a technological solution has finally passed, perhaps we will realize that many of the answers lie directly beneath our feet encoded in the living soil of our lives. The sheer diversity of soil conditions demand a diversity of locally-relevant culturally appropriate properly scaled approaches to terrestrial and institutional change. Let us then replace the race to the top with a reflection upon the bottom, the place from which we arise, and encourage not a distant obsession but a detailed localized introspection, and recall living soil as an embodiment of eternal life right beneath our feet, crusted upon our fingernails, entwined in our foods as well as guts.

Conclusion

The five principles that link pedology to pedagogy—valuing biocultural diversity, sensitizing our senses, recognizing place, cultivating interconnection, and embracing practical experience—combine to offer a regenerative alternative to the dominant modernistic paradigm, nurtured within an environment of curiosity and wonder and set to the rhythm and scale of localized ecologies.

It is clear that the modernistic metaphors that now characterize education are inappropriate and insufficient for enlivening a vibrant discourse on sustainability education. We feel that regenerative frameworks must be articulated as guides to help sustainability educators find a new path and pedagogy. Pedology, with specific reverence for living soil, offers one such fertile frame for moving forward with sustainability education theory and practice. The language of living soil contrasts that of the modern mechanistic industrial paradigm in tangible ways. By engaging with school learning gardens, educators can bring students into literal contact with a living soil; through metaphorizing these experiences our hope is to design one possible ecological landscape within which to situate sustainability education.

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