Manuscript in press for *International Journal of Science Education* (Special Edition: Environmental Education and Science Education), 24 (11) 2002, pp. 1217-1237.

Thinking/acting locally/globally: Western science and environmental education in a global knowledge economy

Noel Gough
Deakin University, Victoria, Australia

Summary
This essay critically appraises a number of approaches to 'thinking globally' in environmental education, with particular reference to popular assumptions about the universal applicability of Western science. Although the transnational character of many environmental issues demands that we 'think globally', I argue that the contribution of Western science to understanding and resolving environmental problems might be enhanced by seeing it as one among many local knowledge traditions. The production of a 'global knowledge economy' in/for environmental education can then be understood as creating transnational 'spaces' in which local knowledge traditions can be performed together, rather than as creating a 'common market' in which representations of local knowledge must be translated into (or exchanged for) the terms of a universal discourse.

Thinking globally in environmental education: first approximations
Think globally. Act locally. These familiar exhortations have circulated within the slogan system of environmental education for nearly three decades. Usually they are invoked as a pair, but environmental educators have not necessarily translated them into practice in comparable or commensurate ways. Many educational programs incorporate local action on environmental issues—often very effectively—but evidence of 'thinking globally' is more elusive, equivocal and problematic. We can readily observe learners performing a school energy audit, participating in a recycling project, propagating locally indigenous plants to revegetate a degraded site, and so on. But what constitutes compelling evidence of learners, teachers and curriculum developers 'thinking globally'? In practical and performative terms, what do environmental educators *mean* when they say they are 'thinking globally' and, perhaps more importantly, what *should* they mean?

According to Ruth and William Eblen (1994), Nobel Laureate and molecular biologist Rene Dubos coined the phrase 'think globally, act locally' in 1972, when he chaired the group of scientific experts advising the United Nations Conference on the Human Environment held that year in Stockholm.[1] We might thus interpret the UNESCO-UNEP[2] International Environmental Education Programme (IEEP), which commenced in 1974 and is still active, as one of the early (post-Stockholm) manifestations of 'thinking globally' in environmental education. This intergovernmental program has sponsored many projects that promote and support local and regional educational action in response to concerns about the quality of the global environment. However, the products of 'thinking globally' in such projects are

---

1 Many other sources identify Dubos as the author of this phrase, but the Eblens include his 1972 essay, titled 'Think Globally, Act Locally', in their edited collection, *The Encyclopedia of the Environment*. Donna Hanson (1995) confirms the bibliographic accuracy of the *Encyclopedia* in a review for the *Electronic Green Journal*, a refereed journal edited and published by (and principally for) 'green' university librarians.

2 UNEP: United Nations Environment Programme.

determined, at least in part, by the differential power relations that accompany intergovernmental cooperation (or the appearance thereof). For example, critics of the IEEP, including Annette Gough (1999), argue that it has cultivated a neo-colonialist discourse in environmental education by systematically privileging Western (and especially US) interests and perspectives.

By the mid-1980s, 'think globally, act locally' was an axiom of environmental education, a self-evident 'truth' that no longer required an expert's authorisation.[3] For example, in *Earthrights: Education as if the Planet Really Mattered*, Sue Greig, Graham Pike and David Selby (1987: 20) treat 'think globally, act locally' as a taken-for-granted principle, apparently without seeing any need to cite its author(ity). Other texts published in the late 1980s that implicitly or explicitly valorise variations on this principle include Pike and Selby's (1987) *Global Teacher, Global Learner,* John Fien's (1989) *Living in a Global Environment*, David Hicks and Miriam Steiner's (1989) *Making Global Connections,* and the World Wide Fund for Nature's (WWF) Global Environmental Education Programme (see, for example, Huckle 1988).[4] These texts equate 'thinking globally', with knowing and caring about the global dimensions and significance of environmental problems and issues. For example, as part of the curriculum rationale for *What We Consume*, John Huckle (1988: 2) writes:

> Starting with products such as a tin of corned beef, a packet of potato crisps or a unit of electricity, teachers and pupils are encouraged to trace commodity chains and recognise their connections to such environmental issues as deforestation in Amazonia, the draining of wetlands in Britain and the debate over acid rain in Europe.

Although all of these texts infer that 'thinking globally' means making 'connections' between one's (local) experience and conditions elsewhere in the world, there are discernible differences of emphasis between them. For example, *What We Consume* emphasises the material linkages of commodity chains, whereas many of the activities in *Living in a Global Environment* begin by encouraging readers to empathise with the lived experience of people enduring (and suffering) very different circumstances from those enjoyed by most people in industrialised nations. *Living in a Global Environment* draws extensively on material first published by *New Internationalist* magazine and thus includes first-hand accounts by people living in developing countries as well as reports by Western aid workers and journalists.

These approaches do not exhaust the possible and potential meanings of 'thinking globally'. For example, I recall that when I first saw *Global Teacher, Global Learner* in a publisher's display, its title triggered a fleeting memory of juvenile novel, *School in the Skies*, that I had read in the early 1950s. Other than the title, I remember only that the story recounted the fictitious adventures of a group of children and teachers whose 'school' for one

---

[3] Note, however, that environmental educators were not alone in appropriating Dubos's aphorism. Theodore Levitt (1983: 92) used a similar phrase—'Think global. Act local'—to encapsulate his view that 'the globalization of markets is at hand' in an article for the *Harvard Business Review*. Of course, the imperative to think globally has a longer history. For example, in 1967 Marshall McLuhan noted that with the advent of an electronic information environment, 'all the territorial aims and objectives of business and politics [tend] to become illusory' (McLuhan and Fiore 1967: 5). 'Think global. Act local' is still a popular trope in both environmental and economic discourses. For example, I conducted an Internet search on 30 October 2000 that identified several hundred sites quoting the phrase (or minor variants on it). Within the top ten, two sites featured articles titled 'Think Global, Act Local': one was GLOBE (Global Legislators Organisation for a Balanced Environment) International, the other was Invest in Britain Bureau.

[4] For convenience, I have cited only one volume in the WWF Global Environmental Education Programme, namely, the teachers' handbook for the *What We Consume* curriculum module. In addition to Huckle's (1988) teachers' handbook, the module consisted of ten book-length units. *What We Consume* is one four modules in the program.

term was an aeroplane that took them from country to country around the world. *School in the Skies* reminds me that although 'travel broadens the mind' might be a cliché, it is part of a constellation of meanings that informs our understanding of 'thinking globally'. However, none of the texts to which I have referred suggests that shifting our geographical locations might enhance our capacity to 'think globally'. More importantly, while all of these texts make some effort to encourage readers to shift their perceptual locations—to 'see' the world from other standpoints—they do not, for the most part, question the privileged status of the Western knowledge systems within which their truth claims are produced. I hasten to point out that I espoused very similar conceptions of 'thinking globally' around this time (see Gough 1992) and must therefore emphasise that I make this judgement with the benefit of considerable hindsight. Thus I admit that it might be unreasonable to expect school textbooks published ten or more years ago to generate such questions. Books such as John Fien and Rod Gerber's (1988) edited collection, *Teaching Geography for a Better World*, introduced teachers to feminist, antiracist and multicultural perspectives on educational values and practices, but the underlying paradigms of knowledge production in Western natural and social sciences received scant attention. However, my main purpose here is not to disparage texts produced more than a decade ago but, rather, to draw attention to the limited range of meanings of 'thinking globally' that are sedimented in them.

Thinking globally in environmental education: current positions

To bring my discussion of 'thinking globally' into the present, I will focus on some of the implicit and explicit ways in which this concept is represented in *Environment, Education and Society in the Asia-Pacific: Local Traditions and Global Discourses*, edited by David Yencken, John Fien and Helen Sykes (2000a). This book brings together some of the significant findings of a comparative study of attitudes to nature and ecological sustainability, particularly among young people, in twelve countries in the Asia-Pacific region.[5] Some of the key questions explored in this study concern the relative influence of, and relationships between, local traditions and practices and global environmental discourses. Indeed, Yencken (2000: 4) begins the book's first chapter by restating—and then inverting—Dubos's familiar maxim:

> To protect the planet, we have long been told to think globally and act locally. But we can readily see that there are as many reasons to think locally and act globally. If we do not think locally, we may ignore rich sources of environmental knowledge and devalue local understanding and experience of environmental problems. If we do not act globally, we will never solve the big issues of the global commons: atmospheric and ocean pollution and the impacts of environmental degradation across national boundaries. Sustainability has many local and global dimensions.

Yencken's chapter provides a thoughtful and culturally sensitive review of the various attitudes toward nature that can be found in both the Eastern and Western nations of the Asia-Pacific region. Yencken focuses not only on contemporary ecopolitical positions in the countries studied but also reviews the history of Western engagement with the environmental philosophies of Eastern cultures. For example, he revisits Lynn White's (1967) paper, 'The historical roots of our ecological crisis', which raised questions about the relative ecophilosophical virtues of Judeo-Christian and other traditions, such as Buddhism, and appraises some of the subsequent debates about their respective merits. Although there was

---

[5] The countries in which this comparative research was conducted are Australia, Brunei, Fiji, India, Indonesia, Japan, New Zealand, Papua New Guinea, the Philippines, Singapore, South China and Thailand.

increasing interest in Eastern (and other) worldviews in Western countries throughout the 1970s and '80s, Yencken (2000: 14) notes that the first 'full scale attempt… within the English-speaking world to review Eastern attitudes to nature' did not appear until the publication of J. Baird Callicott and Roger Ames's (1989) edited collection, *Nature in Asian Traditions of Thought: Essays in Environmental Philosophy*, which compared Chinese, Japanese, Buddhist and Indian worldviews with those that have predominated in the West.

Callicott and Ames's (1989) conclusions concerning the relative merits and reciprocal effects of Eastern and Western environmental thought are, at least superficially, sympathetic to the former. For example, they assert that 'Eastern traditions of thought represent nature and the relationship of people to nature, in ways that cognitively resonate with contemporary ecological and environmental ideals' and that 'the brute fact that environmental degradation is rampant in much of Asia' is best explained by the 'intellectual colonisation' of the East by the West (Callicott and Ames 1989: 279). However, Yencken notes that many of the assumptions underlying these conclusions have been challenged. For example, he cites evidence of 'a history of serious environmental destruction in pre-modern Japan' and claims that for millennia 'the Japanese have attempted to conquer nature in much the same ways that Westerners have done' (Yencken 2000: 17). I have some additional concerns about Callicott and Ames's (1989) conclusions, including their apparent obliviousness to the 'intellectual colonisation' that attends their own textual practices. One sign of intellectual colonisation is what Susan Hawthorne (1999: 121) calls the 'unmarked category'. For example, in the informational domains of the Internet, US addresses are unmarked but every other country is identified by the final term: au for Australia, sg for Singapore, za for South Africa, and so on. Unmarked cultural categories, such as whiteness in most Western countries, are especially troublesome for those of us who reside within them because they designate power and privilege. In Callicott and Ames's (1989: 279) comparison of 'Eastern traditions of thought' with 'contemporary ecological and environmental ideals' the unmarked category is 'Western', that is, they tacitly privilege contemporary *Western* 'ecological and environmental ideals' as criteria that in some way validate Eastern philosophies (they also diminish 'Eastern traditions of thought' by inferring that they are not 'contemporary').

In retrospect, Callicott and Ames (1989: xvii) do not seem to have achieved their avowed purpose of encouraging 'the more thorough integration of Eastern thought into the philosophy curricula of American (and presumably other English speaking) universities'. Seven years after its publication, their book is not even included in a selected bibliography on university-level environmental education that one of them (Callicott) was responsible, at least in part, for compiling (see Callicott and da Rocha 1996: 225-9). Indeed, one of the more curious features of Callicott and da Rocha's (1996) *Earth Summit Ethics: Toward a Reconstructive Postmodern Philosophy of Environmental Education,* is the extent to which 'Eastern traditions of thought' are marginalised.[6]

I have perhaps digressed by interpolating my own criticisms of Callicott and Ames (1989) into Yencken's (2000) discussion of their work, because it is Yencken's arguments that I wish to engage. However, I also want to demonstrate the extent to which I concur with Yencken by providing my own reasons for disputing the authors with whom he takes issue. Yencken's

---

6 *Earth Summit Ethics* was the product of a conference of environmental philosophers from 'Atlantic Rim' nations and, in their Introduction to the volume, Callicott and da Rocha (1996: 9) explicitly compare 'reconstructive postmodern philosophy on the Atlantic Rim' with 'comparative environmental philosophy on the Pacific Rim' This is not the place to debate these characterisations which, I would argue, tend to essentialise and homogenise the internal diversity of approaches to ecophilosophy in each region. However, given the editors' assertion that the 'current environmental crisis calls for an intellectual analogue of the global ecosystem—a variety of approaches that, though apparently competing, are, more deeply, complementary' (Callicott and da Rocha 1996): 9-10), I find it puzzling that the remainder of the book considers only regional (Atlantic Rim) rather than global complementarities in environmental thought.

judgements on the environmental philosophies he compares are circumspect and, very largely, descriptive rather than evaluative (his critical comments are mostly directed towards other Western academics' appraisals of Eastern philosophies). Nevertheless, the conclusions towards which he draws reveal his hopes for 'the emergence of a global ideology of nature that transcends individual cultures' (Yencken 2000: 23):

> The environmental problems now facing the world are global problems stemming from the process of industrialization and capitalist development that has been taking place in every country, albeit at different speeds and intensities. We therefore need contemporary concepts to help frame both the nature of the problems and their likely solution, together with simple, widely applicable models for analysing and approaching environmental problems. These concepts (sustainability, ecology, biodiversity, natural capital, intergenerational equity, precautionary principle and the like) and working models and techniques (metabolism, ecological footprint, natural step, environmental space, industrial ecology, etc.) need to gain widespread international acceptance. They should be developed cooperatively by scientists, environmental thinkers, local communities and others working hand in hand, with contributions from all cultures (Yencken 2000: 24-5).

Although Yencken clearly respects 'contributions from all cultures', he nevertheless privileges (albeit implicitly) Western science as the prime source of the 'contemporary concepts… working models and techniques' that 'need to gain widespread international acceptance'. Many of the concepts, models and techniques that Yencken lists as examples—ecology, biodiversity, metabolism—are already foreclosed to a considerable extent by their production within Western scientific discourses, and so I find it difficult to imagine how they could be 'developed cooperatively by scientists, environmental thinkers, local communities and others'. I find at least four assumptions underlying Yencken's position somewhat troubling.

First, Yencken's use of the term 'contemporary' is problematic, in part because some of the concepts to which he refers already have long histories in some cultures (for example, the concept of intergenerational equity is emphasised in the oral traditions of a number of Native American peoples, although the extent to which various groups actually managed natural resources in ways that would achieve such equity is a matter of considerable debate (see, for example, Gary Paul Nabhan 1995). More importantly, 'contemporary' seems here to be coterminous with 'Western scientific'. That is, he usually juxtaposes 'contemporary' with 'traditional' and seems to see only Eastern traditions as persisting in any significant way into the present. For example, Yencken (2000: 13) describes the 'great environmental awakening' that took place in the US and elsewhere in the wake of Rachel Carson's (1962) *Silent Spring*, and the 'new consciousness of Spaceship Earth' that led citizens of Western industrialised nations to recognise that at least some of their environmentally damaging behaviours were rooted in 'the Judeo-Christian tradition. Yencken (2000: 24) cites research suggesting that this tradition of environmental thought has now been superseded by a form of 'contemporary environmentalism' that constitutes a 'single cultural consensus about the environment' in countries such as the US, Austria and Sweden. Although Yencken (2000: 25) rejects attempts 'to project Western priorities onto Eastern countries or Eastern traditions into Western cultures', he also asserts that 'Western cultures undoubtedly have… much to learn from Asian traditional attitudes to nature in the same way that Eastern cultures have much to learn from Western environmentalism'. Here, only Western environmentalism is tacitly 'contemporary' and only in Eastern cultures do traditional attitudes to nature persist into the present. For example, Yencken does not assert that 'Western cultures have much to learn from

contemporary Asian attitudes to nature' or that 'Eastern cultures have much to learn from traditional Western (i.e. Judeo-Christian) environmentalism'.

Secondly, I am puzzled by Yencken's assumption that models for analysing and approaching environmental problems should be 'simple' and 'widely applicable'. My point here is itself simple and need not be laboured: recent developments in many fields of science and technology have exposed the limits of simple, reductionist, context-free models for analysing and predicting change in complex, dynamic systems, including those we think of as evolutionary and ecological (see, for example, Khalil and Boulding 1996, Schneider and Kay 1994).[7]

A third difficulty with Yencken's formulation of 'contemporary concepts' is the assumption that they can meaningfully be shared across cultures in ways that might be helpful in framing global environmental problems and their possible solutions. For example, the term 'ecology' does not command shared meaning even *within* the culture that has been most responsible for its development as a 'big idea' in environmental thinking. To which and to whose ecology is Yencken referring? Many current school environmental education programs continue to represent ecology in ways that resemble the systems ecology promulgated by Eugene Odum (1971) in the various editions of his textbook, *Fundamentals of Ecology*, between 1953 and 1971. For example, the new study design for Environmental Science, a subject offered to students in the senior secondary school years 11 and 12 as part of the Victorian Certificate of Education (Victoria, Board of Studies 2000), presents an atomistic and reductionist view of large-scale ecosystem structure and function. In Unit 1: The Environment, the first area of study is titled 'Ecological components and interaction' and its specification begins:

> The Earth's structure may be classified into four major categories: hydrosphere, lithosphere, atmosphere and biosphere. This area of study examines the processes occurring within the spheres of the Earth and the interactions that occur in and between the ecological components of each major category (Victoria 2000: 12).

The second area of study in Unit 1, 'Environmental change', focuses on the ecosystem as the unit for analysis. Neither the arbitrary categorical separation of the 'spheres' or the emphasis on ecosystems is consistent with many 'contemporary' approaches to environmental analysis. For example, Donald Worster (1993) describes in detail the ways in which, over the past two decades and more, ecologists have repudiated Odum's portrayal of orderly and predictable processes of ecological succession culminating in stable ecosystems, yet this is an explicit item of curriculum content in Victoria's Environmental Science course (Victoria 2000: 13). Typical of such repudiations are the essays collected by Steward Pickett and P.S. White (1985), which deliver the consistent message that the very concept of the ecosystem has receded in usefulness and, to the extent that the word 'ecosystem' remains in use, that it has lost its former implications of order and equilibrium. Similarly, Andrew Jamison (1993: 202) describes 'the failure of systems ecology to contribute very much to the actual solution of environmental problems':

> By the late 1970s, systems ecology had lost much of its public appeal, although it continued to develop as a research program. Within ecology, however, new evolutionary approaches had become increasingly popular, so that systems ecology today is only one

---

[7] See also Gough (1991) for a detailed demonstration of how using a 'simple' systems model in a school environmental education program distorts the analysis of a specific environmental problem, namely, the Himalayan 'eco-crisis'.

> (and not even the most significant one at that) of a number of competing ecological paradigms.

Why should a school Environmental Science course in the year 2000 privilege an approach to ecology that many environmentalists regarded as a 'failure' more than twenty years ago? And if there are 'a number of competing ecological paradigms' within contemporary Western environmental science, how does Yencken see 'ecology' functioning as a concept that might help to 'frame both the nature of the problems and their likely solution' when it is at the same time a site of conceptual contestation?

These questions bring me to the fourth and most troubling assumption that I perceive in Yencken's position. Yencken (2000: 23) clearly believes in the *possibility*—and perhaps even the *necessity*—of a unitary and universal understanding of nature that 'transcends individual cultures' and also appears to accept that Western science is the best approximation to such an understanding that humans have imagined to date. Yencken and his coeditors elaborate their position on Western science in a subsequent chapter of *Environment, Education and Society in the Asia-Pacific* (Yencken, Fien and Sykes 2000b), in which they are at pains both to recognise and respect feminist, postcolonialist and multiculturalist critiques of modernist Western science. Nevertheless, they maintain the position that a culturally transcendent environmental science is possible—that what they name as 'science' provides the key to both thinking and acting globally. For example, Yencken, Fien and Sykes (2000b: 30) assert that: 'It is generally accepted that most scientific research takes place within global theoretical assumptions'. This is a very curious statement, because many of the feminist, postcolonialist and multiculturalist critiques that these authors claim to respect do *not* accept that the 'theoretical assumptions' within which 'most scientific research takes place' are 'global'. Indeed, one extreme way to characterise these critiques is, to paraphrase Bruno Latour (1993), to assert that *we have never thought globally*.[8]

Western science: thinking locally, acting imperially

Until relatively recently in human history, the social activities through which distinctive forms of knowledge are produced have for the most part been localised. The knowledges generated by these activities have thus borne what Sandra Harding (1994: 304) calls the idiosyncratic 'cultural fingerprints' of the times and places in which they were constructed. The knowledge signified by the English word 'science' is no exception, because it was uniquely coproduced with industrial capitalism in seventeenth century northwestern Europe. The internationalisation of what we now call 'modern Western science'[9] was enabled by the colonisation of other places in which the conditions of its formation (including its symbiotic relationship with industrialisation) were reproduced.

The global reach of European imperialism has given Western science the *appearance* of universal truth and rationality, and many people (regardless of their location) assume that it is a form of knowledge that lacks the cultural fingerprints that seem much more conspicuous in knowledge systems that have retained their ties to specific localities, such as the 'Blackfoot

---

8 This deliberately provocative formulation is inspired by the title of Latour's (1993) book, *We Have Never Been Modern*. Normally, I am reluctant to use terms like 'we' (which implies that I can speak for others) and 'never' (which suggests an absolutism that I cannot defend).

9 I realise that the term 'modern *Western* science' (as distinct from 'science' or 'modern science') reproduces a problematic 'West versus the rest' dualism and seems to overlook the historical influences of other cultures, such as Islam, India, and China, on its evolution. However, I also want to emphasise that I am referring to science as it was produced in Europe during a particular historical period and to those of its cultural characteristics that have endured to dominate Western (and many non-Western) understandings of science as a result of Euro-American imperialism.

physics' described by F. David Peat (1995, 1997) and comparable knowledges of nature produced by other indigenous societies. This occlusion of the cultural determinants of Western science has contributed to what Harding (1993: 1) calls an increasingly visible form of 'scientific illiteracy', namely, 'the Eurocentrism or androcentrism of many scientists, policymakers, and other highly educated citizens that severely limits public understanding of science as a fully social process':

> In particular, there are few aspects of the 'best' science educations that enable anyone to grasp how nature-as-an-object-of-knowledge is always cultural… These elite science educations rarely expose students to systematic analyses of the social origins, traditions, meanings, practices, institutions, technologies, uses, and consequences of the natural sciences that ensure the fully historical character of the results of scientific research.

Over the last few decades, various processes of political, economic, and cultural globalisation, such as the increasing volume of traffic in trade, travel, and telecommunications networks crisscrossing the world, have helped to make some multicultural perspectives on 'nature-as-an-object-of-knowledge' more visible, including the indigenous knowledge systems popularised in terms such as the 'wisdom of the elders' (Knudtson and Suzuki 1992) or 'tribal wisdom' (Maybury-Lewis 1991). The publication in English of studies in Islamic science (e.g. Sardar 1989) and other postcolonial perspectives on the antecedents and effects of modern Western science (e.g. Third World Network 1988, Petitjean, Jami and Moulin 1992, Sardar 1988) has raised further questions about the interrelationships of science and culture. However, economic globalisation simultaneously (and contradictorily) encourages both cultural homogenisation *and* the commodification of cultural difference within a transnational common market of knowledge and information that remains dominated by Western science, technology, and capital.

Scepticism about the universality of Western science provokes a variety of responses from scientists and science educators. Aggressive (and well-publicised) defenders of an imperialist position include scientists such as Paul Gross and Norman Levitt (1994) who heap scorn and derision on any sociologists, feminists, postcolonialists, and poststructuralists who have the temerity to question the androcentric, Eurocentric, and capitalist determinants of scientific knowledge production.[10] Although I am sure that many Western science educators take a similar position to Gross and Levitt,[11] I prefer to attend to the more subtle and insidious forms of imperialism manifested by science and environmental educators whose ideological standpoints appear to be much closer to my own. That is why I focus much of my critical attention here on Yencken, Fien and Sykes's (2000a) work, whose respect for non-Western cultures is, I believe, sincere. Nevertheless, I will argue that for all of their undeniably good intentions, these authors maintain a culturally imperialistic view of science through the use of rhetorical strategies that privilege Western scientists' representations of 'reality' and reproduce the conceit that the knowledge Western science produces is universal.

---

[10] Gross and Levitt (1994) give the impression that the academic left's 'quarrels with science' are chiefly the result of ignorance, scholarly incompetence, irrationality and/or ideological prejudice, an impression they underscore with a litany of personal abuse: for example, they refer to Sandra Harding's 'megalomania' (132), Donna Haraway's 'delusions of adequacy' (134), and Katherine Hayles's 'mathematical subliteracy' (104) for whose work 'the word *crackpot* unkindly leaps to mind' (103, emphasis in original).

[11] I have neither sought nor read published examples of science educators engaging in the kind of attack on critics of Western science mounted by Gross and Levitt, although I have heard these authors quoted or referred to with approval and even admiration by some science education researchers and teachers at academic and professional conferences and other gatherings.

For example, one way in which Yencken, Fien and Sykes (2000b: 32) privilege Western science is to stipulate its uniqueness—'we depend on science for the formal analysis of the physical world and the monitoring of environmental change'—and to insinuate that its unique object ('the physical world') somehow renders it acultural: *'While* science is culturally shaped…, environmental science is *nevertheless* dealing with physical reality' (my emphasis). Yencken, Fien and Sykes (2000b: 33) clearly intend the word 'formal' to signify something special about Western science, since they repeat and amplify this claim: 'we rely on science for the formal analysis of environmental conditions and change. We have no more informed source to depend upon'. But other environmental educators such as Martin Ashley (2000) question this dependence and ask if science might not be 'an unreliable friend to environmental education'.[12]

Yencken, Fien and Sykes (2000b) imply a universal 'we' but their assertions are culture-bound. Are they suggesting that non-Western knowledge traditions *ignore* 'the formal analysis of the physical world' and do *not* '[monitor] environmental change'? Or are they merely saying that non-Western analyses of the physical world and environmental change are 'informal'? What difference are they implying between what is 'formal' and what is not? What rhetorical work are the words I have emphasised in the previous paragraph *('While…nevertheless')* doing? What has 'dealing with physical reality' got to do with the cultural shaping of knowledge traditions? In what sense is Western science an 'informed source'? 'Informed' by what (and/or by whom)?

I fear that Yencken, Fien and Sykes (2000b) overstate the uniqueness of Western science. For example, Peat's discussion of Blackfoot knowledge traditions demonstrates that Western cultures have no monopoly on forms of knowledge production that have the qualities that these authors attribute to 'science'. Peat (1997: 566-7) describes 'the nature of Blackfoot reality' as 'far wider than our own, yet firmly based within the natural world of vibrant, living things… a reality of rocks, trees, animals and energies':

> Once our European world saw nature in a similar way, a vision still present in poets like Blake, Wordsworth and Gerard Manley Hopkins who perceived the immanence and inscape of the world. Nevertheless our consciousness has narrowed to the extent that matter is separated from spirit and we seek our reality in an imagined elsewhere of abstractions, Platonic realms, mathematical elegance, and physical laws.
>
> The Blackfoot know of no such fragmentation. Not only do they speak with rocks and trees, they are also able to converse with that which remains invisible to us, a world of what could be variously called spirits, or powers, or simply energies. However, these forces are not the occupants of a mystical or abstract domain, they remain an essential aspect of the natural, material world.

I am not suggesting that the Blackfoot view of reality is in any way superior (or inferior) to Western environmental science. Rather, I argue that the Blackfoot people analyse the physical world (and more) and monitor environmental change in ways that are no less 'formal' than Western environmental science. They, like us, are interested in 'dealing with physical reality'. They rely on their knowledge tradition 'for the formal analysis of environmental conditions and change'. They have no more informed source to depend upon.

Cultures other than those found in modern industrialised nations have developed ways of 'dealing with physical reality' and 'monitoring environmental change' that are 'formal' in different ways from those privileged by Western science. They cannot be diminished by

---

[12] Ashley here follows David Pepper (1996) who describes science as an unreliable friend to environmentalism.

insinuating that they are not 'formal' or not 'informed'. For example, as David Turnbull (1991, 2000) points out, people from south-east Asia began systematically colonising and transforming the islands of the south-west Pacific some ten thousand years before what is Eurocentrically described as the 'birth of civilisation' is alleged to have taken place in the Mediterranean basin. The Micronesian navigators combined knowledge of sea currents, marine life, weather, winds and star patterns to produce a sophisticated and complex body of natural knowledge which, combined with their proficiency in constructing large sea-going canoes, enabled them to transport substantial numbers of people and materials over great distances in hazardous conditions. They were thus able to seek out new islands across vast expanses of open ocean and to establish enduring cultures throughout the Pacific by rendering the islands habitable through the introduction of new plants and animals. While the knowledge system constructed by these people did not involve the use of either writing or mathematics it is patronising and indefensible to suggest that it is any less concerned with 'physical reality' than Western science, or that it lacks a 'formal analysis of environmental conditions'.

Indeed, some anthropologists are convinced that indigenous people decipher 'physical reality' using homologous assumptions to Western scientists, including a disposition to use systematic empirical inquiry as a means of revealing the inherent orderliness of nature. For example, Brent Berlin's (1990: 19-20) field research suggests that the biological classification systems developed by many indigenous groups are 'intellectualist'—that is, driven by curiosity about natural order and structure—rather than motivated only by a need to know which organisms are useful for practical purposes. Berlin therefore sees the difference between, say, Linnean taxonomy and an indigenous classification system as chiefly one of degree: assisted by European imperialism, Linnaeus had access to a much larger sample of organisms than taxonomists who sampled relatively smaller locations and classified fewer organisms. But given the vast numbers of organisms populating the earth, no system of classification—including contemporary Western phylogenies—can claim universality. Reviewing a number of similar anthropological studies, Susantha Goonatilake (1998: 70-1) concludes:

> The world, it appears, is thus littered with indigenous starting points for potential trajectories of knowledge—trajectories which, if they were developed, would have led to different explorations of physical reality. The existence of all this anthropological evidence does not solve the problem of Western ethnocentricity or of the distinctive rise of Western science, but it does help to further problematize them.

If the knowledge produced by Western scientists was 'consumed' only in cultural sites dominated by Western science, then their claim to its universality would be a relatively harmless conceit. However, attempts to generate global knowledge in areas such as health (necessitated, in part, by the global traffic in drugs and disease) and environment (for example, global climate change) draw increasing attention to the cultural biases and limits of Western science. For example, Brian Wynne (1994: 172-3) reports that up to the early 1990s the Intergovernmental Panel on Climate Change (IPCC) used models of climate change that equated global warming mainly with carbon emissions and largely ignored other factors such as cloud behaviour, marine algal fixing of atmospheric carbon, and natural methane production. Western scientists and policy makers represented the IPCC models as a means for producing universally warranted conclusions, whereas many non-Western observers saw these models as reflecting the interests of developed nations in obscuring the exploitation, domination, and social inequities underlying global environmental degradation. But if global warming is understood as a problem for *all* of the world's peoples, then we need to find ways

in which *all* of the world's knowledge systems—Western, Blackfoot, Islam, whatever—can jointly produce appropriate understandings and responses. I will not presume to suggest (indeed, I cannot imagine) what a Blackfoot or Islamic contribution to such jointly produced knowledge might be, but I am willing to assert that a coexistence of knowledge systems is unlikely to be facilitated by the adherents of any one local knowledge tradition claiming that we *must* 'rely' and 'depend' on theirs.

The successive failures of the Kyoto Climate Change Summit in December 1997 and The Hague World Conference on Climate Change in November 2000 to reach effective transnational agreements on limiting greenhouse gas emissions demonstrate the difficulty of turning the rhetoric of 'thinking globally' into tangible environmental action. Press reports from The Hague Conference indicate how deeply the putative 'global science' of climate change is enmeshed in local contexts, even among Western nations. This is not just because the conclusions Western scientists draw about aspects of global warming—such as how forests and farm crops function as 'carbon sinks'—are contradictory or controversial, but also because the same 'scientific facts' produce different meanings for different people. Thus, for example, Simon Mann (2000: 15) reports that 'the definition of a forest' was among at least 30 areas of disagreement, chiefly between negotiators from the European Union and the US (and its allies in the so-called 'umbrella' group including Australia, Canada, Japan, New Zealand and Russia). I suspect that the impulse to attempt such a definition results from the false hope that some useful scientific truth claims can be made about all forests in the world, and their effects on atmospheric warming, regardless of their location. But each forest's local history and contingencies will uniquely determine the quantities of atmospheric carbon it fixes and solar heat it absorbs and radiates.

However, as an environmental educator I am less concerned about the warrant for Western scientific knowledge of the relationship between global warming and, say, atmospheric carbon fixing by vegetation, than with the conflation of Western science and 'global science'. Press reports and educational texts alike give the impression that the concept of a 'carbon sink' is now a legitimate component of 'thinking globally' (and scientifically) about climate change. For example, one of the required outcomes of Unit 3, 'Ecological issues: energy and biodiversity', in Victoria's Year 12 Environmental Science course (Victoria 2000: 22), is that students 'should be able to describe the principles of energy and relate them to the contribution of a fossil and a non-fossil energy source to the enhanced greenhouse effect'. To achieve this outcome, students are expected to demonstrate knowledge of, among other things, 'scientific application in options for reducing the enhanced greenhouse effect, such as Greenhouse Challenge, National Greenhouse Strategy, Kyoto protocol, emission trading and vegetation sinks' (23). Associating 'emission trading and vegetation sinks' with 'scientific' approaches to 'reducing the enhanced greenhouse effect' gives them a global legitimacy they do not deserve. The 'scientific facts' of carbon fixing by plants do not in themselves legitimate the metaphorical representation of forests as carbon 'sinks'. The 'sink' metaphor is a rhetorical device for recruiting 'scientific facts' to assist the political efforts of industrialised nations to discount their greenhouse gas emissions.

By associating emission trading and carbon sinks with 'scientific application' and international conferences on climate change, the authors of Victoria's Year 12 Environmental Science course insinuate that these terms have global currency—that they are part of the semiotic apparatus that supports 'thinking globally'. But emission trading and carbon sinks are terms for thinking locally—terms that allow Western politicians and bureaucrats to represent mysterious[13] physical realities in the familiar language of economic rationalism.

---

[13] I use the term 'mysterious' because I suspect that very few of the people who take political positions on emission trading and on discounting emissions by counting carbon sinks—including many of the 5000 delegates from the 180 nations or more represented at The Hague World Conference on Climate Change—

Examples such as these lead me to dispute Yencken, Fien and Sykes's (2000b: 32) claims, quoted previously, that 'we depend on science for the formal analysis of the physical world and the monitoring of environmental change' and that 'while science is culturally shaped…, environmental science is nevertheless dealing with physical reality'. We cannot depend on Western science alone because environmental science deals not only with physical reality but also with 'culturally shaped' representations of this reality. Pretending that these representations are acultural is an imperialist act—an act of attempted intellectual colonisation.

How can we think globally?

My story so far is a cautionary tale. In Jon Wagner's (1993: 16) terms, I have tried to identify some of the 'blind spots and blank spots' that configure the 'collective ignorance' of science and environmental educators as we struggle to realise defensible ways of thinking globally. In Wagner's schema, what we 'know enough to question but not answer' are blank spots; what we 'don't know well enough to even ask about or care about' are blind spots—'areas in which existing theories, methods, and perceptions actually keep us from seeing phenomena as clearly as we might'. Much of the research reported by Yencken et al. (2000a) and their coresearchers clearly responds to blank spots in our emerging understandings of the complexities that arise from the interreferencing of local traditions and global discourses of environmental education. My principal concern here is with the blind spots that might still remain in the vision of even the most culturally sensitive environmental educators. The detectable traces of Western scientific imperialism in Yencken et al's (2000a) work underscore the difficulties we face when we attempt, as Patti Lather puts it, 'to decolonize the space of academic discourse that is accessed by our privilege' (quoted in Pinar and Reynolds, 1992: 254), How can we think globally *without* enacting some form of epistemological imperialism?

As Lorraine Code (2000: 68) observes, 'addressing epistemological questions along a local-global spectrum raises timeworn questions about relativism versus absolutism'. For example, David Hess (1995: 2-4) argues that understanding science and technology in a multicultural world demands that we think in terms of 'social constructivism' and 'cultural relativism', but he explicitly eschews the need to invoke epistemological, metaphysical or moral relativism. On the other hand, Code (2000: 69) argues that 'responsible global thinking *requires* not just cultural relativism but a *mitigated epistemological relativism* conjoined with a "healthy skepticism"' (emphases in original). She continues:

> I am working with a deflated conception of relativism remote from the 'anything goes' refrain which anti-relativists inveigh against it. It is 'mitigated' in its recognition that knowledge-construction is always constrained by the resistance of material and human-social realities to just any old fashioning or making. Yet, borrowing Peter Novick's words, it is relativist in acknowledging 'the plurality of criteria of knowledge… and deny[ing] the possibility of knowing absolute, objective, universal truth' (1988, 167). Its 'healthy skepticism' in this context manifests itself in response to excessive and irresponsible global pretensions, whose excesses have to be communally debated and negotiated with due regard to local specificities and global implications.

Code's 'mitigated epistemological relativism' bears a strong resemblance to what Katherine Hayles (1993) calls 'constrained constructivism' (although Code does not seem to recognise

---

have even a rudimentary understanding of the molecular biology and cellular physiology of atmospheric carbon fixing by plants.

this resemblance). Put briefly, Hayles (1993: 32-3) argues that 'within the representations we construct, some are ruled out by constraints, others are not' and that 'by ruling out some possibilities… constraints enable scientific inquiry to tell us something about reality and not only about ourselves'. Hayles emphasises that constraints do not—indeed cannot—tell us what reality *is* but, rather, that constraints enable us to distinguish representations that are consistent with reality from those that are not. For example, the Newtonian representation of gravity as a mutual attraction between masses is very different from gravity's representation in Einstein's general theory of relativity as an effect of the curvature of space. These are in turn different from a Native American belief that objects fall because the spirit of Mother Earth calls out to kindred spirits in other bodies. But no representation of gravity that in Code's terms is 'constrained by… material and human-social realities' could predict that when someone steps off a cliff she would remain suspended in mid-air. Different cultures interpret these constraints in different ways, but they operate multiculturally—and globally—to eliminate some constructions. Hayles notes that for any given phenomenon, there will always be other representations, unknown or unimaginable, that are consistent with reality: 'The representations we present for falsification are limited by what we can imagine, which is to say, by the prevailing modes of representation within our culture, history, and species'.[14] Hayles (1993: 33-4) concludes:

> Neither cut free from reality nor existing independent of human perception, the world as constrained constructivism sees it is the result of active and complex engagements between reality and human beings. Constrained constructivism invites—indeed cries out for—cultural readings of science, since the representations presented for disconfirmation have everything to do with prevailing cultural and disciplinary assumptions.

As I have argued in greater detail elsewhere (Gough 1998), Hayles articulates very clearly a philosophical position that should commend itself to science educators—a position that problematises the non-discursive 'reality' of nature without collapsing into antirealist language games. Constrained constructivism is not 'anything goes' but neither does it disallow representations that fail to meet criteria that disguise their Eurocentric and androcentric biases behind claims for universality. But, as the example of systems ecology referred to above demonstrates, many science and environmental educators (including those who espouse constructivism) often seem to do the precise opposite of what Hayles suggests by requiring learners to *confirm* representations that conform to 'cultural and disciplinary assumptions' that no longer prevail even in the West.

The literatures that I find most useful for thinking about 'thinking globally'—and about the articulations between global (or transnational) and local knowledge production—are broadly speaking those that Sandra Harding (1998b) calls Post-Kuhnian and postcolonial science and technology studies, and in particular the work of David Turnbull (1994, 1997, 2000). Turnbull argues that all knowledge traditions are spatial in that they link people, sites and skills. His approach is thus to recognise knowledge systems (including Western science) as sets of local practices so that it becomes possible to 'decentre' them and develop a framework within which different knowledge traditions can equitably be compared rather than absorbed into an imperialist archive. From the postcolonialist and anti-imperialist standpoints that Harding and Turnbull share, all knowledges are always situated and constituted initially

---

[14] Note that analysing the consistency between reality and a representation is different from applying Karl Popper's (1965) doctrine of falsification, because Popper maintained that congruence is a conceptual possibility. But, as Hayles (1993: 35) explains, the most we can say is that a representation is 'consistent with reality as it is experienced by someone with our sensory equipment and previous contextual experience. Congruence cannot be achieved because it implies perception without a perceiver'.

within specific sets of local conditions and cultural values. However, there are subtle and thought-provoking differences between their respective positions. Put crudely, Harding seems more interested in the universalising tendencies that accompany the 'travel' of knowledges beyond the localities in which they were initially produced, whereas Turnbull is more concerned with how trust is established between heterogeneous knowledges that 'arrive' (or are produced) in the same space. For example, after reviewing the various implications of postcolonialist and feminist science and technology studies for research epistemologies and methodologies, Harding (1998b: 46) argues that the distinction between 'universally valid knowledge' and 'merely local opinion' (e.g. superstitions, folk knowledges) is much less useful than older epistemologies supposed:

> If, as the post-Kuhnian, postcolonial and feminist accounts argue, all knowledge systems have integrity with the cultures that produce them and continue to find them useful, then nothing in principle is possible but local opinion—though some local opinions (e.g., the laws of gravity) definitely travel farther and retain usefulness longer than do others. (…) More productive is the project of seeking to understand the devices through which originally local knowledges (as all are) get to circulate and travel far from their origin, and how the most effective balances between these universalising tendencies and the necessary localising tendencies have been and can be nourished and maintained.

Elsewhere, Harding (1998a: 182) again uses travel metaphors to capture her sense of the ways in which 'different modern scientific projects have maintained valuable tensions between the local and the global':

> the most widely successful [knowledge systems], such as many parts of modern sciences, manage to travel effectively to become useful in other sets of local conditions—parts of nature, interests, discursive resources, ways of organizing the production of knowledge—that are different in significant respects from those that originally produced them. Without claiming a universality for them that we can now see is historically and conceptually misleading, how could we usefully think about valuable tensions between the local and this movability, or ability to travel, that has characterized parts of modern sciences in particular, but also parts of other knowledge systems (e.g., the concept zero and acupuncture)?

Turnbull detaches a knowledge tradition's 'ability to travel' from any assumptions about its supposed 'universalising tendencies', preferring instead to find ways in which different knowledge systems can coexist. An important feature of Turnbull's (1997: 553) strategy is to abandon an 'overly representational view of knowledge' and to recognise that all knowledge is 'both performative and representational'. In other words, Turnbull is less interested in characterising science's 'ability to travel' by reference to the movement of representations and abstractions (such as 'the laws of gravity' or 'the concept zero' to which Harding refers) and more concerned with the *activity* of knowledge production in particular social spaces. Thus, Turnbull (1997: 553) argues that we can reconceive the social history of knowledge production 'in a variety of intersecting and overlapping ways which move beyond simple contextualisation' (that is, cultural relativism):

> Science may be seen as a history of visualisation or as a history of measurement and rational calculation. However, I would like to argue that a particularly perspicuous cross-cultural history of knowledge production is as a social history of space. That is as a

> history of the contingent processes of making assemblages and linkages, of creating spaces in which knowledge is possible.

Turnbull uses diverse examples, including gothic cathedral-building in medieval Europe, the establishment of modern cartography, and rice farming in Indonesia, to show how particular knowledge spaces are constructed from differing social, moral and technical components in a variety of cultural and historical contexts—from 'assemblages' of people, skills, local knowledge and equipment linked by various social strategies and technical devices. Turnbull (1997: 553) suggests that from this 'spatialised' perspective, concepts such as universality, objectivity, rationality, efficacy and accumulation 'cease to be unique and special characteristics of technoscientific knowledge':

> rather these traits are effects of collective work of the knowledge producers in a given knowledge space. To move knowledge from the local site and moment of its production and application to other places and times, knowledge producers deploy a variety of social strategies and technical devices for creating the equivalences and connections between otherwise heterogeneous and isolated knowledges. The standardisation and homogenisation required for knowledge to be accumulated and rendered truthlike is achieved through social methods of organising the production, transmission and utilisation of knowledge. An essential component is the social organisation of trust.[15]

Turnbull (1997: 553) argues that a major analytic advantage of this spatialised perspective is that, because all knowledge systems have localness in common, many of the small but significant differences between them can be explained in terms of the different kinds of work—of *performance*—that are involved in constructing 'assemblages' from the people, practices, theories and instruments in a given space. Although some knowledge traditions move and assemble their products through art, ceremony and ritual, the productivity of Western science has so far been accomplished by forming disciplinary societies, building instruments, standardising techniques and writing articles. Turnbull (1997: 553) thus concludes that each form of knowledge production entails 'a process of knowledge assembly through making connections and negotiating equivalences between the heterogeneous components while simultaneously establishing a social order of trust and authority resulting in a knowledge space. It is on this basis that it is possible to compare and frame knowledge traditions'.

Turnbull (2000) analyses knowledge construction among different groups of people in different locations and times, including medieval masons, Polynesian navigators, cartographers, malariologists and turbulence engineers. He demonstrates that, in each case, their achievements are better understood performatively—as diverse, messy, contingent, unplanned and arational combinations of social and technical practices—rather than as the result of logical, orderly, rational planning or a dependence on internal epistemological features to which 'universal' validity can be ascribed. As already noted, the purpose of Turnbull's emphasis on analysing knowledge systems comparatively in terms of spatiality and

---

[15] Turnbull here echoes Steven Shapin (1994: 36) who argues in his social history of science in 17th century England that the basis of knowledge is not empirical verification (as the orthodox view of 'scientific method' has it) but trust: 'Mundane reason is the space across which trust plays. It provides a set of presuppositions about self, others, and the world which embed trust and which permit both consensus and civil dissensus to occur'. In a gesture towards Bruno Latour's (1987, 1993) 'actor network theory', Turnbull (1997: 553) also suggests that the linking of heterogeneous components of a knowledge system is achieved by both social strategies and 'technical devices which may include maps, templates, diagrams and drawings, but are typically techniques for spatial visualisation'.

performance is to find ways in which diverse knowledge traditions can coexist rather than one displacing others. The significance of his analysis for 'thinking globally' in environmental education is demonstrated by two examples of the consequences of Western scientists' attempts to displace the knowledge spaces constructed by Indonesian rice farmers with their own. Turnbull (1997: 559-60) writes:

> The Green Revolution and the introduction of high-yield rice turned Indonesia from being a net importer of rice unable to feed its own population to being one of the biggest rice exporters. This was achieved [in Java] at the price of using massive amounts of fertiliser and pesticides and in the abandonment of indigenous rice strains. That success, as we have become accustomed to expect, was short-lived. Insect pests started reaching plague proportions in the monocrop environment and increased applications of pesticide only made the problem worse. The solution was the banning of fertiliser and pesticide imports and the introduction of 'integrated pest management'. This is an… approach to pest control which recognises there will always be pests and the best way to manage them is to ensure that the populations of competing insects remain in balance. For this system to work, the local farmers had to become local experts, they had to monitor the insect populations on their own farms and to use locally appropriate rice strains.
>
> A similar reversal occurred in Bali where rice is grown under an irrigation system controlled by the temples. The Indonesian government thought this old fashioned and superstitious and introduced modern scientific methods of water control and distribution. The result was the same as in Java: initial success followed by a crash in production. So they brought in more Western experts, but this time they included a rather unusual anthropologist and a computer expert. Between them they were able to show on the computer screen how the old system of temple control worked and why it was the most efficient. This resulted in the knowledge and power being given back to the local people while satisfying the central government's yen for high-tech solutions.

These examples suggest to me that the globalisation of knowledge production depends on creating spaces in which local knowledge traditions can be 'reframed, decentred and the social organisation of trust can be negotiated' (Turnbull 1997: 560-1). Stanley Jeyaraja Tambiah (1990: 122) and Edward Soja (1996) name the space that Turnbull envisages as 'a third space', whereas Homi Bhabha (1994: 312) calls it 'an interstitial space'—a space created through 'negotiation between spaces, where contrasting rationalities can work together but without the notion of a single transcendent reality' (Turnbull 2000: 228). The production of such a space is, in Turnbull's (1997: 560-1) view, 'crucially dependent' on 'the reinclusion of the performative side of knowledge':

> Knowledge, in so far as it is portrayed as essentially a form of representation, will tend towards universal homogenous information at the expense of local knowledge traditions. If knowledge is recognised as both representational and performative it will be possible to create a space in which knowledge traditions can be performed together.

Turnbull invites us to be suspicious of importing and exporting representations that are disconnected from the performative work that was needed to generate them. For example, representing forests as 'carbon sinks' arises in Western industrialised nations because their emissions of greenhouse gases are of sufficient magnitude to motivate and make meaningful the work of producing 'sinks' to which excessive atmospheric carbon can be removed. The resistance of some developing nations to accepting carbon sinks as a way for Western nations to discount their greenhouse gas emissions is only to be expected, because the 'sink' metaphor

has no cultural purchase in their localities. Sheila Jasanoff argues that 'global knowledge' must be 'co-produced' and that its legitimacy cannot be tied to any one culture's social and political traditions for conferring legitimacy on knowledge construction (see Turney 1997).

If we think about coproducing knowledge in 'interstitial' transnational spaces, it becomes clear that some of the most revered processes of Western knowledge production will not necessarily appear to be trustworthy. For example, many of the truth claims that constitute Western scientific knowledge of nature are produced under laboratory conditions.[16] But, as Code (2000: 71) argues, developing 'methodological strategies for ecologically-framed global thinking' requires a more 'naturalized' epistemology than laboratory work assumes:

> I maintain that the laboratory is neither the only nor the best place for epistemologists to study 'natural' human knowing in order to elaborate epistemologies that maintain clearer continuity with cognitive experiences—'natural knowings'—than orthodox *a priori*-normative epistemologies do. I advocate turning attention to how knowledge is made and circulated in situations with a greater claim to the elusive label 'natural.' My interests are in ways of gathering empirical evidence and in assumptions about the scope of evidence as it plays into regulative theories. My contention, briefly, is that evidence gathered from more mundane sites of knowledge production can afford better, if messier, starting points for naturalistic inquiry than much of laboratory evidence, for it translates more readily into settings where knowing matters in people's lives and the politics of knowledge are enacted.

For example, despite claims for the 'objectivity' of experimental methods, the methodological principle of controlling variables produces knowledge that can be incomprehensible in locations where this principle is not taken for granted. Again, as Code (2000: 71) notes: 'Descriptions, mappings, and judgments that separate evidence from extraneous "noise" are always value-saturated, products of some one's or some group's location and choice; hence always contestable'.

In light of the above considerations, I suggest that 'thinking globally' in science and environmental education might best be understood as a process of creating transnational 'spaces' in which scholars from different localities collaborate in reframing and decentering their own knowledge traditions and negotiate trust in each other's contributions to their collective work. For those of us who work in Western knowledge traditions, a first step must be to represent and perform our distinctive approaches to knowledge production in ways that authentically demonstrate their localness.

I have no 'conclusions' to offer in this essay, merely cautions. We may not be able to speak—or think—from outside our own Eurocentrism, but we can continue to ask questions about how our specifically Western ways of 'acting locally' (in the production of knowledge) might be performed with other local knowledge traditions. By coproducing global knowledge in transnational spaces, we can, I believe, help to make both the limits *and strengths* of the local knowledge tradition we call Western science increasingly visible.

References

[16] I write 'under laboratory conditions' rather than 'in laboratories' because Western scientists typically try to create (or assume) laboratory conditions when they are working elsewhere. Indeed, Latour (1983) notes that a large proportion of national budgets for scientific activity is contributed to the work of international agencies that maintain standard weights and measures so that, in effect, the world at large can be treated as a giant laboratory.

Ashley, Martin (2000) Science: an unreliable friend to environmental education? *Environmental Education Research* 6 (3): 269-280.

Berlin, Brent (1990) The chicken and the egg-head revisited: further evidence for the intellectualist bases of ethnobiological classification. In Posey, Darrel A. and Overal, William Leslie (eds) *Ethnobiology: Implications and Applications. Proceedings of the First International Congress of Ethnobiology, Volume 1* (Belem, Brazil: Museo Emilio Goeldi), 19-35.

Bhabha, Homi K. (1994) *The Location of Culture* (New York: Routledge).

Callicott, J. Baird and Ames, Roger T. (eds) (1989) *Nature in Asian Traditions of Thought: Essays in Environmental Philosophy* (Albany NY: State University of New York Press).

Callicott, J. Baird and da Rocha, Fernando J.R. (eds) (1996) *Earth Summit Ethics: Toward a Reconstructive Postmodern Philosophy of Environmental Education* (Albany NY: State University of New York Press).

Carson, Rachel (1962) *Silent Spring* (New York: Houghton Mifflin).

Code, Lorraine (2000) How to think globally: stretching the limits of imagination. In Narayan, Una and Harding, Sandra (eds) *Decentering the Center: Philosophy for a Multicultural, Postcolonial, and Feminist World* (Bloomington and Indianapolis: Indiana University Press), 67-79.

Eblen, Ruth A. and Eblen, William R. (eds) (1994) *The Encyclopedia of the Environment* (Boston and New York: Houghton Mifflin).

Fien, John (ed.) (1989) *Living in a Global Environment: Classroom Activities in Development Education* (Brisbane: Australian Geography Teachers Association).

Fien, John and Gerber, Rod (eds) (1988) *Teaching Geography for a Better World* Second ed. (London: Oliver and Boyd).

Goonatilake, Susantha (1998) *Toward a Global Science: Mining Civilizational Knowledge* (Bloomington and Indianapolis: Indiana University Press).

Gough, Noel (1991) An abominable snow job: systems models and the Himalayan 'eco-crisis' in VCE [Victorian Certificate of Education] Environmental Studies. *Eingana* 14 (4): 24-26.

Gough, Noel (1992) *Blueprints for Greening Schools: Principles, Policies and Practices for Environmental Education in Australian Secondary Schools* (Melbourne: Gould League of Victoria).

Gough, Noel (1998) All around the world: science education, constructivism, and globalization. *Educational Policy* 12 (5): 507-524.

Gough, Annette (1999) Recognising women in environmental education education pedagogy and research: toward an ecofeminist poststructuralist perspective. *Environmental Education Research* 5 (2): 143-161.

Greig, Sue, Pike, Graham and Selby, David (1987) *Earthrights: Education as if the Planet Really Mattered* (London: World Wildlife Fund and Kogan Page).

Gross, Paul R. and Levitt, Norman (1994) *Higher Superstition: The Academic Left and its Quarrels with Science* (Baltimore and London: The Johns Hopkins University Press).

Hanson, Donna M. (1995) Review of *The Encyclopedia of the Environment* (Ruth A. Eblen and William R. Eblen, eds). *Electronic Green Journal* 2 (2): http://egl.lib.uidaho.edu/egl04/hanson01.html (accessed 30 October 2000).

Harding, Sandra (1993) Introduction: Eurocentric scientific illiteracy—a challenge for the world community. In Harding, Sandra (ed.) *The 'Racial' Economy of Science: Toward a Democratic Future* (Bloomington and Indianapolis: Indiana University Press), 1-22.

Harding, Sandra (1994) Is science multicultural? Challenges, resources, opportunities, uncertainties. *Configurations: A Journal of Literature, Science, and Technology* 2 (2): 301-330.

Harding, Sandra (1998a) *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies* (Bloomington and Indianapolis: Indiana University Press).

Harding, Sandra (1998b) Multiculturalism, postcolonialism, feminism: do they require new research epistemologies? *Australian Educational Researcher* 25 (1): 37-51.

Hawthorne, Susan (1999) Connectivity: cultural practices of the powerful or subversion from the margins? In Hawthorne, Susan and Klein, Renate (eds) *CyberFeminism: Connectivity, Critique and Creativity* (North Melbourne: Spinifex Press), 119-133.

Hayles, N. Katherine (1993) Constrained constructivism: locating scientific inquiry in the theater of representation. In Levine, George (ed.) *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature and Culture* (Madison WI: University of Wisconsin Press), 27-43.

Hess, David J. (1995) *Science and Technology in a Multicultural World: The Cultural Politics of Facts and Artifacts* (New York NY: Columbia University Press).

Hicks, David and Steiner, Miriam (eds) (1989) *Making Global Connections: A World Studies Workbook* (Edinburgh: Oliver and Boyd).

Huckle, John (1988) *What We Consume: The Teachers' Handbook* (Richmond, Surrey: Richmond Publishing Company).

Jamison, Andrew (1993) National political cultures and the exchange of knowledge: the case of systems ecology. In Crawford, Elizabeth, Shinn, Terry and Sörlin, Sverker (eds) *Denationalizing Science: The Contexts of International Scientific Practice* (Dordrecht: Kluwer), 187-208.

Khalil, Elias L. and Boulding, Kenneth E. (eds) (1996) *Evolution, Order and Complexity* (London and New York: Routledge).

Knudtson, Peter and Suzuki, David (1992) *Wisdom of the Elders* (Sydney: Allen & Unwin).

Latour, Bruno (1983) Give me a laboratory and I will raise the world. In Knorr-Cetina, K.D. and Mulkay, M. (eds) *Science Observed: Perspectives on the Social Study of Science* (New York: Sage Publications),

Latour, Bruno (1987) *Science in Action: How to Follow Scientists and Engineers through Society* (Catherine Porter, trans.). (Milton Keynes: Open University Press).

Latour, Bruno (1993) *We Have Never Been Modern* (Catherine Porter, trans.). (Cambridge, Massachusetts: Harvard University Press).

Levitt, Theodore (1983) The globalization of markets. *Harvard Business Review* 83 (3): 92-102.

Mann, Simon (2000, 22 November) Hill puts case on greenhouse gas. *The Age* (Melbourne), 15.

Maybury-Lewis, David (1991) *Millennium: Tribal Wisdom of the Modern World* (London: Viking).

McLuhan, Marshall and Fiore, Quentin (1967) *The Medium is the Massage* (New York: Bantam Books).

Nabhan, Gary Paul (1995) Cultural parallax in viewing North American habitats. In Soulé, Michael E. and Lease, Gary (eds) *Reinventing Nature? Responses to Postmodern Deconstruction* (Washington DC: Island Press), 87-101.

Novick, Peter (1988) *That Noble Dream: The 'Objectivity' Question and the American Historical Profession* (Cambridge MA: Cambridge University Press).

Odum, Eugene P. (1971) *Fundamentals of Ecology* Third ed. (Philadelphia PA: W.B. Saunders).

Peat, F. David (1995) *Blackfoot Physics* (London: Fourth Estate).

Peat, F. David (1997) Blackfoot physics and European minds. *Futures* 29 (6): 563-573.

Pepper, David (1996) *Modern Environmentalism: An Introduction* (London and New York: Routledge).

Petitjean, Patrick, Jami, Catherine and Moulin, Anne Marie (eds) (1992) *Science and Empires: Historical Studies about Scientific Development and European Expansion* (Dordrecht: Kluwer).

Pickett, Steward T.A. and White, P.S. (eds) (1985) *The Ecology of Natural Disturbance and Patch Dynamics* (Orlando, Florida: Academic Press).

Pike, Graham and Selby, David (1987) *Global Teacher, Global Learner* (London: Hodder and Stoughton).

Pinar, William F. and Reynolds, William M. (1992) Appendix: Genealogical notes—the history of phenomenology and post-structuralism in curriculum studies. In Pinar, William F. and Reynolds, William M. (eds) *Understanding Curriculum as Phenomenological and Deconstructed Text* (New York: Teachers College Press), 237-261.

Popper, Karl (1965) *Conjectures and Refutations: The Growth of Scientific Knowledge* Second ed. (New York: Basic Books).

Sardar, Ziauddin (ed.) (1988) *The Revenge of Athena: Science, Exploitation and the Third World* (London and New York: Mansell).

Sardar, Ziauddin (1989) *Explorations in Islamic Science* (London and New York: Mansell).

Schneider, Eric D. and Kay, James J. (1994) Complexity and thermodynamics. Towards a new ecology. *Futures* 26 (6): 626-647.

Shapin, Steven (1994) *A Social History of Truth: Civility and Science in 17th Century England* (Chicago: University of Chicago Press).

Soja, Edward (1996) *Thirdspace: Journeys to Los Angeles and Other Real-and-Imagined Places* (Cambridge MA: Blackwell).

Tambiah, Stanley Jeyaraja (1990) *Magic, Science, Religion, and the Scope of Rationality* (Cambridge: Cambridge University Press).

Third World Network (1988) *Modern Science in Crisis: A Third World Response* (Penang, Malaysia: Third World Network).

Turnbull, David (1991) *Mapping the World in the Mind: An Investigation of the Unwritten Knowledge of the Micronesian Navigators* (Geelong: Deakin University).

Turnbull, David (1994) Local knowledge and comparative scientific traditions. *Knowledge and Policy* 6 (3/4): 29-54.

Turnbull, David (1997) Reframing science and other local knowledge traditions. *Futures* 29 (6): 551-562.

Turnbull, David (2000) *Masons, Tricksters and Cartographers: Comparative Studies in the Sociology of Scientific and Indigenous Knowledge* (Amsterdam: Harwood Academic Publishers).

Turney, Jon (1997, 13 August) Can science studies save the world? *The Australian*: p. 37.

Victoria, Board of Studies (2000) *Environmental Science: Study Design* (Carlton, Victoria: Board of Studies).

Wagner, Jon (1993) Ignorance in educational research: or, how can you *not* know that? *Educational Researcher* 22 (5): 15-23.

White, Lynn (1967) The historical roots of our ecological crisis. *Science*(155): 1204-1207.

Worster, Donald (1993) *The Wealth of Nature: Environmental History and the Ecological Imagination* (New York: Oxford University Press).

Wynne, Brian (1994) Scientific knowledge and the global environment. In Redclift, Michael and Benton, Ted (eds) *Social Theory and the Global Environment* (London: Routledge), 169-189.

Yencken, David (2000) Attitudes to nature in the East and West. In Yencken, David, Fien, John and Sykes, Helen (eds) *Environment, Education and Society in the Asia-Pacific: Local Traditions and Global Discourses* (London and New York: Routledge), 4-27.

Yencken, David, Fien, John and Sykes, Helen (eds) (2000a) *Environment, Education and Society in the Asia-Pacific: Local Traditions and Global Discourses* (London and New York: Routledge).

Yencken, David, Fien, John and Sykes, Helen (2000b) The research. In Yencken, David, Fien, John and Sykes, Helen (eds) *Environment, Education and Society in the Asia-Pacific: Local Traditions and Global Discourses* (London and New York: Routledge), 28-50.