This is a draft paper. The positions taken are defensible as of March 16, 1995.
Quote at the risk of knowing that I change my mind frequently.

Regarding nature in new times: reconceptualising studies of science and environment

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Symposium abstract: new subjects for new times
For education and schooling the times, as usual, are changing. A key characteristic of the 'new times' with which education is expected to keep pace is the emergence of media culture (including new global circuits of information and entertainment and the digital convergence of broadcasting, publishing and computing) as a principal agency of socialisation and identity formation. Schooling can no longer claim privileged status in the production and reproduction of knowledge and information or the induction of young people into society.
This symposium addresses some problems and possibilities of 'new subjects' of schooling in these new times. The term 'subjects' here has a (deliberately) double meaning, since we refer not only to the emergence of new forms of student subjectivity but also to the new subject-matters which are emerging—or must emerge—as schooling adapts to its changing milieux. Our individual papers explore 'new subjects for new times' by reference to three constructs, namely, nature, culture and the body.1 These constructs are convenient foci for inquiries concerned with school subjects since they correspond (albeit crudely) with three broad, and relatively noncontroversial, areas of school curriculum (ie, it is usually taken-for-granted that schooling should provide students with opportunities to learn something about the 'natural' world, the worlds that humans make, and their own bodies).

Regarding nature

This paper explores some of the problems and possibilities of doing 'nature study' in schools in the light of changing and contested relationships between nature and culture. The unity and stability of

the meanings we attribute to nature are relevant to contemporary curriculum debates because such meanings underlie, in Shane Phelan's (1993: 45) terms, 'several crucial nodes of political argument':

ideas about justice, of the desirability of change, of freedom and the limits of human action, of the source and possibility of knowledge, all involve differing senses and aspects of nature. The destabilization of nature is the opening into a new politics and a new common life, but only if its many dimensions are explored.

The first part of this paper is an attempt to capture the 'big picture' of this contemporary destabilisation of nature by outlining the complex interplay of four cultural movements (three of which are popularly

overdramatised as 'crises'; this is a categorisation I find problematic but the labels are too familiar and convenient to be ignored), namely: the ecological crisis, the crisis of the (postmodern) self, the crisis of representation, and the development of a global virtual environment as the 'natural' site in which such cultural crises are mediated. In the second part of the paper, I follow just one of the threads in the rhizomatic space of my initial conjectures—namely, representation—in order to examine more closely its implications for the curriculum and pedagogy of 'nature study'.

In modern industrial societies, nature has often been defined as Other. As Phelan (1993: 44) observes, 'the opposition to "culture" provides the bedrock meaning of "nature" in the West, but this opposition has become fraught with tension'. A corollary of this definition is that the opposition to nature 'provides the bedrock meaning' of the 'cultivated' subject—that is, the 'educated' person—in western society. The destabilisation of this particular meaning of nature has been a favorite rhetorical strategy of many 'green' cultural critics. For example, as Tony Fry and Anne-Marie Willis (1989: 230-1) write:

The cultivator, as artist or critic, like the scientist, has so often regarded nature as low, as threat, as transcended origin and therefore in need of conquest and domination. The cultivated subject is seen to be the mind grown above nature and in command of it, totally separate from the baseness of body.

This discourse has self-evidently failed. Humanity has damaged its own ecosystem, its collective and interdependent body, through the alienation of self from a nature that is external, other.

This is conventional wisdom among many environmentalists (and some environmental educators) but Fry and Willis oversimplify the discourse on which they are passing judgment. One difficulty is that when we speak of the 'conquest and domination' of nature we cannot speak of a unitary 'humanity', since it is not so much that 'humanity has damaged its own ecosystem' but that some humans have damaged some others' ecosystems. There are at least a billion people living and dying in

abject poverty in many rural areas of the non-western world because their ecosystems have been damaged irredeemably—but not necessarily because they have positioned themselves outside 'a nature that is external, other'. The precarious existence of people whom we patronizingly locate in 'developing' countries is less a consequence of their 'alienation' from nature than of our alienation from their otherness.

Another difficulty with Fry and Willis's formulation is that it implies that mainly negative consequences—such as the 'alienation of self' from nature—follow from the construction of nature as 'external, other'. By way of contrast, Bill McKibben (1990: 60, 88), in a eulogy for what he calls 'the end of nature', draws attention to the self-constitutive force of differentiating ourselves from nature's externality and otherness:

When I say that we have ended nature, I don't mean, obviously, that natural processes have ceased--there is still sunshine and still wind, still growth, still decay.… But we have ended the thing that has, at least in modern times, defined nature for us—its separation from human society.…

We have killed off nature—that world entirely independent of us which was here before we arrived and which encircled and supported our human society.… In the place of the old nature rears up a new 'nature' of our making. It is like the old nature in that it makes its points through what we think of as natural processes (rain, wind, heat), but it offers none of the consolations—the retreat from the human world, the sense of permanence and even of eternity (emphasis in original).

Thus, McKibben (1990: 7) regrets the loss of a particular meaning of nature—of the 'comforting sense… of the permanence of our natural world', reassuringly impervious to human action and will—but he is not so much grieving the death of nature as mourning the loss of the ontological security blanket with which nature once enveloped us. McKibben is alerting us to the possibility that, by 'killing off' nature as a foundational reality that exists outside of human agency, we have also brought the foundational self into question—by collapsing the boundary that once separated us from nature, we have made it more difficult to recognise and identify ourselves as autonomous, unitary, centred subjects.2 In particular, phenomena like the greenhouse effect and ozone depletion have reduced our confidence in a phenomenologically independent nature. It may still be possible, in Richard Rorty's (1989: 5) terms, to say that a world is 'out there' that is 'not our creation' and that 'most things in space and time are the effects of causes which do not include human mental states', but it is becoming increasingly difficult to identify 'natural phenomena' in our everyday lives that do not bear the mark of human agency.

At the same time as the 'natural' world has, as it were, been 'shrinking', our confidence in western science's authority to represent

'nature'—or indeed any other nonverbal reality—has also been diminishing. In the context of rethinking 'nature study', it is particularly important to emphasise that poststructuralist skepticism about the narratives and metanarratives of western science does not necessarily constitute an antirealist position. What is at issue here is not belief in the real but confidence in its representation. As Rorty (1980: 375) puts it, 'to deny the power to "describe" reality is not to deny reality' and 'the world is out there, but descriptions of the world are not (Rorty 1989: 5).
A further tension in the relations of nature and culture is provided by the tendency for culture itself to be 'naturalised'. For example, Fredric Jameson (1991: ix-x) writes that:

Postmodernism is what you have when the modernisation process is complete and nature is gone for good. It is a more fully human world than the older one, but one in which 'culture' has become a veritable 'second nature'.

McKenzie Wark (1994a: 120) goes a step further than Jameson by equating postmodernism with the qualitative changes in the social relations of culture enabled by 'third nature' (for which he has more recently coined the term 'virtual geography'; see Wark 1994b):

Second nature, which appears to us as the geography of cities and roads and harbours and wool stores is progressively overlayed with a third nature of information flows, creating an information landscape which almost entirely covers the old territories.

As a number of cultural critics have observed (Berland 1994, Ross 1991, Wark 1994a), the destabilisation of the meaning of 'nature' is especially apparent in our experience of weather. While we are still sensitive and attentive to the ways in which we engage physically with the weather, we have also 'naturalised' the technologies through which weather is presented to us as an abstraction: to interpret or forecast the weather we are more likely to look at a television screen than the sky. Our cultural activities—industrial pollution, urbanisation, agribusiness—have quite literally 'constructed' the greenhouse effect but our knowledge of it and the many other complexities of climate change is constructed by the global network of satellites, weather stations, supercomputers, meteorologists and broadcasters that produce the images, models and simulations that are the representations of that knowledge. In this sense, as Jody Berland (1994: 106) writes, 'the weather can no longer be considered "natural"… but (like gender and other previously "natural" concepts) must be understood as [a] socially constructed artifact'. In other words, much of what now counts as 'nature' is the measurement and projection of human culture's interactions with the biosphere in and on the 'virtual geography' of global information flows.

Representing nature

In the light of the foregoing discussion, and my understanding of curriculum as 'the collective [and selective] story we tell our children about our past, our present, and our future' (Grumet 1981: 115), I suggest that to reconceptualise 'nature study' for 'new times' we must struggle to come to pedagogic terms with the 'narrative chaos' generated by the categorical ambiguities that now attend such concepts as self, culture, nature and artefact. At the moment, little of what teachers and learners do in the name of science, geography and environmental studies (to name some of the more common ways in which 'nature study' is included in school curricula) engages this struggle. Sandra Harding (1993: 1) captures one of the crucial inadequacies of modern science education when she speaks of 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 and thus, also, of the nature it studies'; she continues:

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: 'In science, just as in art and life, only that which is true to culture is true to nature.'3 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. …
Being able to explain the regularities of nature and their underlying causal tendencies is inseparable from providing the same kinds of explanations of the social relations of science (Harding 1993: 1, 6).

In addition to the Eurocentrism and androcentrism to which Harding refers, science educators may not have been sufficiently alert to the ways in which scientists have 'naturalised' their own social constructions by assuming that the language in which they couch their representations of natural phenomena is, as Rorty (1980: 368) puts it, 'transparent to the real'. Despite the rhetoric of 'constructivism' that has dominated the literature of science education research for more than a decade (see, for example, Fensham, Gunstone and White 1994), science education in practice continues to indoctrinate children into a realist philosophy of science which claims ontological status for the world western science imagines. By way of illustrating this claim, in the remainder of this paper I will consider in some detail the examples Dick Gunstone (1988: 74) uses to introduce research on students' ideas and beliefs focusing on 'interpretations of natural phenomena' (see exhibit 1). My purpose in so doing is to draw attention to the yawning gap that presently exists between the magnitude and complexity of the intellectual terrain now occupied by 'nature' (as sketched in the first part of this paper) and the absurdly—and

unnecessarily–attenuated sample of that terrain that is explored in conventional science classrooms.

Exhibit 1: Excerpt from ‘Learners in science education (Gunstone 1988:

74)

Research on Students’ Ideas and Beliefs

Interpretations of Natural Phenomena

Thus far, research on students’ ideas/beliefs has largely focused on interpretations of natural phenomena. Hence, this is the starting point of the discussion. Initially some specific examples are described.

Example 1 (from Gunstone and Champagne, in press)

A year 7 class was undertaking a laboratory exercise concerned with solubility and suspension. Five substances were provided, with a small quantity of each to be added to water and observed. One substance was in a reagent bottle with the label ‘Sodium chloride’, quite accidently [sic], clearly visible. Just after adding this substance to water one student was asked by the teacher about his progress. He responded: ‘I knew that [sodium chloride] would dissolve’. When asked how he knew, he replied: ‘Because its got chlorine in it, and chlorine dissolves in swimming pools’.

Example 2: (from Driver et al., 1985)

A physics graduate in a one-year course of teacher training was in a group shown a bell jar containing a partially inflated balloon. When asked to predict what would happen to the balloon when air was evacuated from the bell jar, he answered ‘The balloon will float’. His reason: ‘Because gravity will be reduced’. (p. 86)

Example 3: (from Osborne and Freyberg, 1985)

Large samples of science and physics students from each of the ages 13 to 17 years were given questions about a ball thrown in the air. The questions asked whether the force on the ball was up, down or zero for three positions shown on diagrams – ball rising, ball at highest point, ball falling. The most common response at all five age levels was ‘up, zero, down’. This response, which embraces the belief that a force is needed in the direction of motion to maintain that motion, was given by about half of the 16 and 17-year-old physics students (pp. 45-6).
The first point to note about the three examples Gunstone has chosen is that the ‘natural phenomena’ that students are being asked to interpret are all highly contrived or abstracted. The circumstances described in

example 1 come closest to simulating (to revert to Rorty's formulation) 'the effects of causes which do not include human mental states' (especially if the five substances provided to students are 'naturally occurring' and often found in solution or suspension). However, it is by no means clear that example 1 provides any evidence whatsoever of a student 'interpreting' such a 'natural' process. Gunstone (1988: 74-5) uses this example to illustrate 'one of the consistent findings of research which has probed students' ideas/beliefs', namely, that 'when students come to formal science learning they frequently already hold explanatory views of phenomena… [that] are apparently personal and idiosyncratic interpretations of experiences, and are often different from the explanatory views taught in science classrooms'. But the student in example 1 does not appear to have volunteered—nor been asked to provide—an 'explanatory view' of a natural phenomenon. He made a prediction in a particular instance and defended it on the basis of his interpretation of his own past experience. Since he is not necessarily attempting to provide an explanatory generalisation for a class of 'natural phenomena' it is gratuitous to say that it is 'different from the explanatory views taught in science classrooms'.

To say that the apparatus described in example 2 is intended to demonstrate a 'natural phenomenon' is a little like saying that animals in zoos display 'natural' behaviours. Nevertheless, Gunstone (1988: 75) uses this example to illustrate two more research findings:

[Students' ideas/beliefs] can be remarkably unaffected by traditional forms of instruction. …a tertiary physics graduate… apparently continues to interpret the world around him via a belief that gravity is an atmosphere-related phenomenon (i.e. without air there is no gravity).…
Some students can hold the scientists' interpretations given in instruction together with a conflicting view already present before instruction. The science interpretation is often used to answer questions in science tests, and the conflicting view retained to interpret the world. This is illustrated… by example 2 (where the graduate involved could readily answer questions requiring Newton's Law of Gravitation)…

Without wishing to read too much into Gunstone's words, his discussion of example 2 illustrates the tendency of science educators to naturalise what is socially constructed by referring to a representation as a phenomenon and, further, to privilege a particular representation as the 'one true story' explaining that phenomenon. In Gunstone's account, gravity is accorded the status of natural phenomenon and Newton's Law of Gravitation is the privileged explanation. Yet, as Katherine Hayles (1993: 33) notes, 'Gravity, like any other concept, is always and inevitably a representation'. Thoughtful science educators are unlikely to disagree with Hayles, although they are more likely to refer to 'constructions' than to

'representations'. However, differences between their respective positions emerge when we turn to the question of which of many possible representations should be privileged. For example, Fensham, Gunstone and White (1994: 6) assert that constructivist teaching 'does not give students licence to claim that their meaning is as good as scientists' meaning, no matter what its form'. Moreover, they continue, constructivism 'does not mean "anything goes"; some meanings are better than others. Means for determining what is better are then significant'. They then endorse criteria for explaining a natural phenomenon that are very familiar in the rhetoric of western science, namely, that an explanation should be 'elegant and parsimonious and connected with other phenomena, as well as having… intelligibility, plausibility and fruitfulness… and be testable'. They do not offer criteria for 'testability' since, like all the other criteria these authors recommend, they are embedded in the historically specific practices of interpretation and testimony that characterise the narrative traditions of western science.
Rather than trying to determine that 'some meanings are better than others', Hayles (1993: 33) suggests that 'within the representations we construct, some are ruled out by constraints, others are not'. In Hayles's (1993: 32-3) terms, 'by ruling out some possibilities… constraints enable scientific inquiry to tell us something about reality and not only about ourselves':

Consider how conceptions of gravity have changed over the last three hundred years. In the Newtonian paradigm, gravity is conceived very differently than in the general theory of relativity. For Newton, gravity resulted from the mutual attraction between masses; for Einstein, from the curvature of space. One might imagine still other kinds of explanations, for example a Native American belief that objects fall to earth because the spirit of Mother Earth calls out to kindred spirits in other bodies. No matter how gravity is conceived, no viable model could predict that when someone steps off a cliff on earth, she will remain suspended in midair. This possibility is ruled out by the nature of physical reality. Although the constraints that lead to this result are interpreted differently in different paradigms, they operate universally to eliminate certain configurations from the range of possible answers.

Hayles (1993: 33) emphasises that constraints do not—indeed cannot—tell us what reality is. Rather, constraints enable us to distinguish which representations are consistent with reality and which are not, and their power to do so depends upon 'a certain invariability in their operation':

For example, the present limit on silicon technology is a function of how fast electrons move through the semiconductor. One could argue that 'electron' is a social construction, as are 'semiconductor' and

'silicon.' Nevertheless, there is an unavoidable limit inherent in this constraint, and it will manifest itself in whatever representation is used, provided it is relevant to the representational construct. Suppose that the first atomic theories had developed using the concept of waves rather than particles. Then we would probably talk not about electrons and semiconductors but about indices of resistance and patterns of refraction. There would still be a limit, however, on how fast messages could be conveyed using silicon materials. If both sets of representations were available, one could demonstrate that the limit expressed through one representation is isomorphic with the limit expressed in the other.

Hayles (1993: 33) admits 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' (my emphasis). The term Hayles (1993: 33-4) coins for this position is 'constrained constructivism':

Neither cut free from reality nor existing independent of human perception, the world as constrained constructivism sees it as 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.

I have quoted Hayles at some length because I believe she articulates very clearly a philosophical position that should commend itself to science educators. Her position suggests alternative formations of 'nature study' in the curriculum that problematise the non-discursive 'reality' of nature without collapsing into antirealist language games. Constrained constructivism is not 'anything goes' but neither does it fall into the trap of disallowing representations that fail to meet criteria that disguise their Eurocentric and androcentric biases behind claims for universality—criteria that all too often seem to lead, swiftly and inexorably, to privileging those representations of nature that conform to the mechanistic positivities of Newton's 'world machine'.
Which brings me, finally, to Gunstone's example 3, which he uses to illustrate one of the two research findings he claims are illustrated by example 2:

Some students can hold the scientists' interpretations given in instruction together with a conflicting view already present before instruction. The science interpretation is often used to answer

questions in science tests, and the conflicting view retained to

interpret the world. This is illustrated… by example 3 (where some 50 per cent of senior students holding the force-needed-in-direction-of-motion belief could successfully solve standard F = ma problems).

This example has almost nothing to do with what it claims to be exemplifying—students' interpretations of natural phenomena—but it is typical of a rhetorical strategy that is common in school physics textbooks. The strategy is to reject students' understanding of an ordinary word (in this case 'force') and to replace this word's meaning with a formula (here, F = ma). David Chapman forcefully (!) captures my objections to this strategy:4

The basic claim is: 'Force is "really" mass times acceleration'. The dirty work here is done by the word 'really'. What could it mean? What it means is that physics is claiming the word for its own. It claims to have authoritative knowledge about what force is. It claims that any other meanings for 'force' are deficient, marginal, unscientific, merely intuitive.
This is not a truth claim. It is a grab for power. There is and cannot be any fact-of-the-matter about what 'force' means. Words mean whatever they are used to mean, and 'force' is used to mean 'mass times acceleration' only in very restricted circumstances.
The intellectually honest way to present this concept would be to invent a new word for it, say 'woozle'. Woozle is the product of mass and acceleration. Actually, we are going to need new words for those too, so woozle is the product of frizzle and drizzle. We could go through a physics textbook and systematically substitute these new words in and we'd get a new book that wouldn't be making claims to ownership of any ordinary-language words. I believe that students would have a much easier time with such a book; it would be much easier to learn the new words than to deal with the cognitive dissonance involved in abandoning old ones.
I believe the reason physics continues to claim 'force' for its own can be seen if we imagine the fully-renamed physics textbook about woozle and frizzle. The problem with this book is that it never makes contact with reality. It's a nice consistent mathematical system that isn't about anything. If it is going to describe the world, it either has to have some ordinary words in it to ground it, or else we need to have instruments that measure frizzle and drizzle rather than mass and acceleration.

If this were done, it might become much more obvious to students (and teachers?) that the representations that constitute Newtonian mechanics are culturally determined, socially constructed, context dependent—and by no means the only, let alone the 'best', interpretations of natural phenomena that are consistent with reality.

A gesture towards closure
As indicated at the beginning of this paper, I have only tried to

elaborate here one of the many dimensions of the destabilisation of the meaning of nature that are pertinent to reconceptualising 'nature study' in new times. Elsewhere, I have addressed other dimensions of this issue in more detail, with particular reference to ways in which education as a textual practice can accommodate the multiple subjectivities young people bring to nature and its representations in studies of science and environment (see, for example, Gough 1993abc, 1994). I have no desire to reach any closure on the issues discussed in this paper, but one 'conclusion' to the exercise of producing it may be worth sharing. In preparing to write this paper I sampled several bodies of literature, including cultural and literary studies of

science and nature and the recent literature of 'constructivism' in science education. While the former bodies of literature are marked by the vitality of their attempts to struggle with the complex issues of rethinking human relationships with 'nature', it is painful to see the extent to which the strategic rhetoric of constructivist science education compounds the problem of 'scientific illiteracy' by continuing to reflect and reproduce extraordinarily narrow monocultural models of inquiry, representation, interpretation and explanation as if these were 'natural'.

References

Barglow, Raymond (1994) The Crisis of the Self in the Age of Information: Computers, Dolphins, and Dreams (New York: Routledge).
Berland, Jody (1994) On reading 'the weather'. Cultural Studies 8 (1): 99-114.
Fensham, Peter J., Gunstone, Richard F. and White, Richard T. (eds.) (1994) The Content of Science: A Constructivist Approach to its Teaching and Learning (London: The Falmer Press).
Fleck, Ludwik (1979) Genesis and Development of a Scientific Fact (Chicago: University of Chicago Press); originally published in 1935.
Fry, Tony and Willis, Anne-Marie (1989) Criticism against the current. Meanjin 48 (2): 223-40.
Gough, Noel (1993a) Environmental education, narrative complexity and postmodern science/fiction. International Journal of Science Education 15 (5): 607-25.
Gough, Noel (1993b) Laboratories in Fiction: Science Education and Popular Media (Geelong: Deakin University Press).
Gough, Noel (1993c) Neuromancing the stones: experience, intertextuality, and cyberpunk science fiction. Journal of Experiential Education 16 (3): 9-17.
Gough, Noel (1994) Playing at catastrophe: ecopolitical education after poststructuralism. Educational Theory 44 (2): 189-210.
Grumet, Madeleine R. (1981) Restitution and reconstruction of educational experience: an autobiographical method for curriculum theory. In Lawn, Martin and Barton, Len (eds.) Rethinking Curriculum

Studies: A Radical Approach (London: Croom Helm), 115-130.
Gunstone, Richard F. (1988) Learners in science education. In Fensham, Peter (ed.) Developments and Dilemmas in Science Education (London: The Falmer Press), 73-95.
Haraway, Donna J. (1991) A cyborg manifesto: science, technology, and socialist-feminism in the late twentieth century. In Simians, Cyborgs, and Women: The Reinvention of Nature (New York: Routledge), 149-181.
Harding, Sandra (ed.) (1993) The 'Racial' Economy of Science: Toward a Democratic Future (Bloomington and Indianapolis: Indiana University Press).
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),
Jameson, Fredric (1991) Postmodernism, or, The Cultural Logic of Late Capitalism (London and New York: Verso).
McKibben, Bill (1990) The End of Nature (London: Viking).
Phelan, Shane (1993) Intimate distance: the dislocation of nature in modernity. In Bennett, Jane and Chaloupka, William (eds.) In the Nature of Things: Language, Politics, and the Environment (Minneapolis: University of Minnesota Press), 44-62.
Rorty, Richard (1980) Philosophy and the Mirror of Nature (Princeton NJ: Princeton University Press).
Rorty, Richard (1989) Contingency, Irony, and Solidarity (Cambridge MA:

Cambridge University Press).
Ross, Andrew (1991) Strange Weather: Culture, Science, and Technology in the Age of Limits (London and New York: Verso).
Wark, McKenzie (1994a) Third nature. Cultural Studies 8 (1): 115-32.
Wark, McKenzie (1994b) Virtual Geography: Living with Global Media Events (Bloomington and Indianapolis: Indiana University Press).

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1Obviously, this paper refers to nature. The other papers in this

symposium are 'Teaching the technology subjects: technology, culture and education in new times' by Bill Green, and 'Schooling bodies for new times: school health and physical education' by David Kirk and Richard Tinning.

2These sorts of terms are often invoked in characterising 'the crisis of the self' precipitated by new information technologies (see, for example, Raymond Barglow 1994: 64-5) and biotechnologies (see, for example, Donna Haraway 1991) but less attention seems to have been given to the possible significance of global environmental change in problematising the 'boundaries' of the postmodern subject.

3Harding is quoting Ludwik Fleck (1979 [1935]: 35).

4I have paraphrased an email message posted to the list-server <postech@weber.ucsd.edu> from David Chapman, Stanford University, on Friday 13 March 1992. The subject of his message is titled: 'science is stupid, part nineteen'. One of the examples used by Chapman is based on the claim that 'work = force x distance', for which I have substituted F = ma.