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Science: an unreliable friend to environmental education?

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SUMMARY *This article focuses upon the uneasy relationship between science and environmental education. It argues that science probably offers the strongest justification for the adoption of pro-environmental behaviours and policies, but that the relationship between science and environmentalism is strained by conflicts over fundamental values that are apparent in interpretation of the precautionary principle. An understanding of risk and scientific uncertainty is seen as an essential element of citizenship education for a sustainable society. Curriculum design needs to respond to the challenges of living in a risk society. The article argues for changes to the curriculum which lead to a scientific action competence founded in an understanding of the limits of science and an appreciation of the fact that scientists are moral agents who face ethical dilemmas in their work.*

Introduction

The title of this article is derived from Pepper (1996) who describes science as an 'unreliable friend to environmentalism' when he discusses the uneasy relationship that has developed between science and the deeper green wing of environmentalism. This article intends to explore the tensions that exist between environmentalists who espouse causes such as rapid action to reduce greenhouse gas emissions or risks associated with nuclear waste, and scientists who are committed to the principles of reason based upon evidence and a public understanding of this. After considering the nature of the relationship between a science which can appear conservative through its need for sound evidence and an environmentalism which can appear radical through its demands for social and political action, there will be a discussion about how such tensions culminate in the need to invoke value judgements in formulating the precautionary principle. Finally, ways are considered in which science education can move forward as a key partner of environmental education in the light of this.

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Some Introductory Thoughts on Friendship and Risk

Pepper's unreliable friendship idea encapsulates the principle that science can be capricious through at one moment supporting the environmentalist's cause whilst at another undermining it. In a similar way, environmentalists sometimes appeal to science for evidence to support their cause, yet at other times are seen to be harshly critical of it when writers such as Capra (1983) or Merchant (1992) attack the whole Baconian project of subjugating nature to humankind's progress.

Magnus Magnusson, in the keynote address to the 1994 Association for Science Conference in Inverness (Magnusson, 1994) described how scientists detect warning signs which tell when the Earth is under stress. 'These signs are discovered, measured and monitored by scientists. They are then analysed and the results made public …'(p. 8). In this sense, science is a 'friend' to environmentalism. The present levels of political attention given to, for example, the issue of climate change would surely not exist without the substantial input of science. Such scientific explanation is *powerful*, and for this reason, science is potentially not only a friend but also a prized ally of environmentalism. However, scientific explanation is also *provisional* , and herein lies the problem. As Woollacott (1998) reminds us, science must always hold out against absolute conclusions. Science cannot be there, unfailingly allied to the environmentalist's cause, for it must always admit to doubt and alternative possibilities and works, not with certainties, but with probabilities and managed risks.

This uneasy relationship that has thus developed between science and environmentalism crystallises around the *precautionary principle* where the agenda of certain scientists and certain environmentalists may differ. For some environmentalists, particularly those on the deep-green or eco-radical wing, the precautionary principle requires that where there is risk or uncertainty, and the scientific evidence is inconclusive, precautionary action should be guided by value judgements that favour the natural world. It is at this point that the friendship between science and environmentalism becomes strained. Many scientists feel constrained by such considerations as the 'value-free' thesis that seeks to preserve science from contamination by contextual values. Subsequent weaknesses in potential alliances between science and environmentalism are readily exploited by the growing anti-environmentalist movement which also seeks to enlist science as a powerful ally (see, for example, Aldrich-Moodie & Kwong, 1997).

Behind these difficulties lies the legacy of the post-war period of 1945–65 when, as Durant (1998) suggests, science was the consumer's friend. This period was the heyday of deference to the scientific expert. Science had won its 19th century battle for cultural supremacy and, bolstered by astonishing discoveries such as jet-powered aircraft, atomic power and antibiotics was at the apotheosis of its powers as the oracle of all wisdom. The scientific expert was the person who could tell us what to do and shape and guide our behaviour in all circumstances. This, with hindsight, can now be seen to have been an unfortunate period for science. Since 1965, disasters such as DDT, Bopal or Chernobyl have driven an escalating loss of public confidence in science. It is doubtful that, in the year 2000, science remains the consumer's friend to the degree that it was during the 1950s and 1960s.

The crucial point, however, is that it is not so much science that may be in decline as the ideology of technocentric managerialism, the notion that some kind of paternalistic relationship exists between politicians advised by scientific 'experts' and a technologically and scientifically naive general public. Ulrich Beck's seminal analysis of risk society and reflexive modernity (Beck, 1992) has done much to alert scholars to the political consequences of a realisation that science may have gone the way of theology as the infallible guide to what we ought to do. Beck's analysis concerns itself with the equitable distribution of public 'bads' (such as ground water contamination) in a society which is less at the mercy of nature or 'acts of God', but which has created for itself its own risks. Public and democratic responsibility for the management of such risks is seen by Beck as a core element in his vision of reflexivity in a society that has progressed beyond the modernist notion of growing mass consumption on the basis that nobody is responsible for the environmental consequences.

Yet, if it is truly the case that society is in a period of transition to reflexive modernity in which the most difficult dilemmas of the precautionary principle are to be resolved democratically, educators and policy-makers may have a huge task ahead of them. This has been graphically illustrated in the UK recently by the crisis over British beef. The public expectation that a primary role of government was to protect them from risk, in this case from Creutzfeldt-Jacob Disease, (CJD, strongly linked in the public mind with Bovine Spongiform Encephalopathy, the so-called 'mad cow disease' [BSE]), was seriously undermined, and confidence in the joint action of politicians and scientists fell yet further.

As Tindale (1998) has reasoned, the then Conservative Government's assertion that advice about beef would be based upon 'sound science' was hollow and rhetorical. Who, he asks, would suggest that advice about risk should be based upon 'unsound science'? The government's handling of the BSE crisis demonstrated the alarming inadequacy of British politicians in the face of the kind of technologically-generated uncertainty that is the fundamental postulate of Beck's risk society. Central to the BSE crisis was the government's apparent failure even to understand let alone admit to the limits of science. The National Curriculum for England and Wales, in its present form, was conceived by this same government which, grounded in modernism, promoted the notion of science as the ultimate authority. Yet as Giddens (1998) illustrates, this is a lay-person's view of science, it is not the informed view of the community of scientists who are generally far more realistic about risk, uncertainty and the limits of science than politicians whose understanding of science as often as not is gained from the media or even their own memories of school science.

Since the demise of the Major Government, there has come to power in Britain a 'New Labour' which loudly proclaims its commitment to 'modernisation'. Giddens (1998) is cautiously optimistic that Prime Minister Blair understands and is committed to a reflexive modernisation as envisaged by Beck rather than the kind of regression to the modernity of economic growth that was so unfortunately pursued by the Conservatives. Nevertheless, there is little evidence of this in the nature and content of the year 2000 revisions to the English and Welsh National Curriculum. The crisis of British beef is arguably a small, local and relatively inconsequential affair when compared with the potential consequences of rapid and unprecedented (in human history) climate change.

That humanity's response to global climate change might be handled with a comparable degree of competence to the handling of the beef crisis ought surely to figure as one of the highest concerns of citizens. I now proceed to reflect upon the nature of the precautionary principle and the need for an education about this if members of the public are to take more responsibility for their environment, have more realistic expectations of their politicians, and understand better the nature of science.

Values Conflict and the Precautionary Principle

Procrastination over the adoption of precautionary policies in response to the prospect of global warming has been a characteristic of late 20th century politics. O'Riordan's formulation of the precautionary principle 'thoughtful action in advance of scientific proof' (O'Riordan, 1995) would seem to imply a context in which cultural conflict between an inherently conservative science and an inherently impatient eco-radicalism is possible. At the heart of this conflict is the inescapable conclusion that wherever there are conflicts of evidence, or risk and uncertainty are operative, value judgements need to be made in the formulation of policy.

The possibility of policy-making, at whatever level, being dependent upon values rather than rational procedures based upon logical application of scientific knowledge raises the question of relativism. Is scientific knowledge universal and absolute, or is it merely the set of beliefs of a particular social group, the scientific community? In a relativistic world where the beliefs of the scientific community may come into conflict with the beliefs of alternative social groups, such as what one writer has described as the 'technophobic' eco-radical community (Lewis, 1992), a power struggle for the authority on which claims for rightness of action are based might be inevitable. Some scientists prominent in the public eye, such as Richard Dawkins, object to the grounds on which such a power struggle is conducted. In Dawkins' view, the superiority of scientific authority is to be taken as unquestioned (Dawkins, 1995).

Poole (1996) discusses this potential struggle for cultural supremacy and concludes that reactions against grandiose claims that science is the paradigm of rationality and truth are both likely and a threat to science itself. Drawing upon the New Age movement as an alternative set of values, he describes a countercultural threat to science which is characterised by the denigration of science itself, an anti-rationalist preference for subjectivism, a relativistic interpretation of knowledge and an orientation to mysticism and holism which paradoxically draws inspiration from pseudoscientific writings about quantum mechanics. Unlike Dawkins (1995), however, Poole admits to the possibility of science having legitimate limits, and to the possibility that there are other valid standards of rationality and other kinds of truth than scientific ones.

Such a view would be concordant with a view that has emerged in the official documentation of the UK government, for example, the National Curriculum Council's 1993 pronouncement that schools 'should encourage their pupils to question the often exaggerated view of the infallibility of science as the only means of understanding the world, and the equally exaggerated view of the inadequacy of religion and philosophy' (NCC, 1993, p. 6). Again, the Schools

Curriculum and Assessment Authority (1995) develop this theme when they claim that 'the perception of science as the only way to understand experience, combined with Enlightenment humanism, had been largely responsible for the demise of the spiritual and moral dimensions of the curriculum' (SCAA, 1995, p. 13). Such statements might be construed as in some ways hostile to science.

One way of understanding these cultural conflicts is to examine the core values that underpin science and eco-radicalism. My contention is that at the heart of both of these cultural communities, there lies what is perceived by the community as an absolute value. This value gives the community its identity and a failure to acknowledge it results in exile from the community. For the community of scientists, the fundamental absolute is a belief in the powerful but provisional nature of scientific truth (Lakatos, 1970; Ruse, 1982; Thagard, 1988). 'Truth', in this context, however, is a dangerous word. The notion that 'the truth' is an abstract object that can be possessed is more probably rooted in pre-20th century theology than 21st century science. Gaukroger (1998), for example, discusses the limits of 'truth' as an absolute value of science and points out that the idea that the value and success of scientific activity is to be explained in terms of its proximity to an abstract conception of 'truth' is deeply problematical. He prefers the concept of justification that he defines as processes that enable us to answer questions in ways that fit the available evidence.

The understanding of truth that this engenders points more towards the processes of science and the value of integrity in relation to those processes. Membership of the community of scientists is dependent upon 'telling the truth' in relation to the available evidence rather than 'possessing the truth'. It is this process-oriented value that lies behind the so-called 'value-free' thesis that is often problematic for science and environmentalism. Curd & Cover (1998) summarise the debate on the value-free thesis by drawing attention to Thomas Kuhn's critical distinction between cognitive and contextual values in science (Kuhn, 1996). Kuhn's cognitive values of accuracy, consistency, scope, simplicity and fruitfulness are process-oriented values that allow us to judge scientific theories. Contextual values, on the other hand, are said to be the norms, beliefs and interests that are unrelated to the cognitive aims of science.

Gross examples of the influence of contextual values might be the continuous attack on relativity theory undertaken by Soviet physicists on the grounds of its incompatibility with the official doctrine of dialectical materialism (Stachel, 1990), or the anti-Semitic bias of German science during the Nazi era. It is a less gross, but still problematical influence of contextual values that so concerns Pepper (1991). There can be little doubt that 'the environment' is a context for scientific activity. Can science, therefore, proceed within this context and be free of contextual values? Pepper is perplexed and sets up a polarity between ecocentric and technocentric science, thereby undermining the notion that there is one kind of 'good' science and raising again the possibility of cultural relativism in science.

The fact that it is possible for scientists publicly to disagree about, for example, the degree to which global warming has human causes, leads Pepper to question the extent to which scientific processes are as objective as sometimes claimed. Surely, he argues, 'objective' processes should have arrived at greater consensus than is often the case with environmental issues? He points out that in the 20th century, the scientific research which was or was not done—and the technologi-

cal developments which stemmed from it—was essentially selected according to whether or not it supported the ideologies and purposes of particular groups.

How can we know whether 'good' science is being practised, and what kind of environmental science would thus count as 'good' science? Curd & Cover (1998) seem to imply an orthodox view of 'good' science in which the exclusion of contextual values is the ideal. Is this a realistic basis, however, for science to answer some of our most pressing environmental questions? An alternative might be to consider, as does Thagard (1988), the type of transgression that would result in exile from the scientific community and condemnation of one's activities as 'pseudoscience'. A prime candidate for such exile might be Whitcomb & Morris (1961) and their so-called 'creation science'. Creation science can only proceed once its would be practitioners have affirmed their possession of 'the truth' by allegiance to a dogmatically asserted absolute—that creation was a unique and supernatural act. Thagard condemns astrology, Freudian analysis and Marxism as pseudosciences for similar reasons:

> … the community of practitioners makes little attempt to develop the theory towards solutions of the problems, shows no concern for attempts to evaluate the theory in relation to others, and is selective in considering confirmations and disconfirmations. (p. 32)

Where, then, does environmental science stand? Is it 'good' science, or is it pseudoscience? There are, as Pepper points out, different kinds of environmental science. In discerning 'good' science, however, we might search for the existence of any fundamental absolutes which are prerequisites for community membership and which might be associated with a conflict between cognitive and contextual values. Pepper himself reminds us that to belong to the community of eco-radicals, one must first assent to the absolute value of nature as a guide to all decision-making (Pepper, 1996). He reminds us of the 'deep-green' tendency to define sets of ecological absolutes as referents for all action, whilst remaining either silent or relativist on social issues and dismissive of any form of science or technology which is unrelated to ecological concerns.

For committed eco-radicals, there is no dilemma over the interpretation of the precautionary principle. The belief in the intrinsic value of nature and the inherent 'rightness' of natural processes ensures that a value judgement in favour of the nature preserving option will always be made when determining how the precautionary principle should be interpreted. This provides an attractively (to some) simple solution to an intractably complex problem, much in the way that creationism provides an attractively simple solution to the intractably difficult problem of how we all came into existence and what the purpose of our existence might be. The solutions are simple, and to a degree, workable, but are they authentic?

Masters (1993) extols the virtue of what he calls ancient science. Ancient science seeks to discover the secrets of nature on the grounds that nature cannot be improved and is therefore a model of 'rightness'. We can, according to this view, appeal to the way nature works for guidance about what we ought to do. Szerszynski (1996) however provides a comprehensive analysis of the shortcomings of such an approach. He points out, furthermore, that it is itself a modernist assumption that nature is determinable and describable without reference to human projects and languages. The eco-radical appeal to nature as an absolute

model of rightness which therefore can reliably tell us what to do is itself a product of the modernism that assumes scientific knowledge can attain towards a perfectible reflection of natural reality.

The conclusion to which arguments such as these all seem to point is that we cannot escape responsibility for those of our actions that have environmental consequences. Given that so many of these consequences are the result of the way the public has embraced science and its technological products, the public has to develop a more responsible attitude to science. A scientific education for all that is more likely to result in such responsibility therefore has to be a key objective for environmental education. The next section of this article considers ways in which such improvements in scientific education might come about.

Towards Scientific Action Competence in a Risk Society

If we are to provide an authentic education for the 21st century, we will, at some stage, have to recognise that arguments such as those described will need to be presented to pupils. The English and Welsh National Curriculum as it stands is, in practice, a socially reproductive curriculum of 'no change', informed almost exclusively by the political short-term and economic and materialistic aspirations and values of the 20th century. One starting point for the development of a transformative curriculum more likely to lead to a serious political will to move towards sustainability might be the acknowledgement of the partiality of the way in which science is presented by this curriculum.

Relatively few school pupils will ever become acquainted with the anti-science writings of eco-feminists such as Carolyn Merchant (Merchant, 1992), who remain marginal to the dominant ideology of mainstream culture. Almost all pupils, however, are presented with a view of science that is still largely influenced by logical positivism, reductionism and the 'value-free' thesis. It is, furthermore, a curriculum that is driven primarily by the goal of selection for university entry. Little has changed since Bernstein (1971) wrote of his collection code in which the aim of discrete curriculum subjects was to 'socialise' learners into the university driven hierarchy of those subjects. A school science which is geared to the selection, at age 16, of the minority of pupils who will study 'hard' sciences as a preparation for university entry, is unlikely to be a science which is capable of developing those friendships with other disciplines which may be necessary to create educated citizens who can react rationally to the precautionary principle.

What sort of response to this possibility is appropriate from educators? The most fundamental point of this article is that it cannot be a technophobic or anti-scientific response. Curriculum designers are right to be wary of capitulating to any of the relativist, subjectivist or anti-rationalist pressures from eco-radical idealists. A 'more-of-the-same' approach to the science of modernism, however, would be equally inappropriate. The science of reflexive modernity is a science of uncertainty and a science with limits. It is, moreover, an inherently more democratic form of science. It is not the science of university researchers who see no need to communicate with the public, nor the science of technocentric managerialism in which 'experts' tell the politicians what to do.

If there are to be acknowledged limits to science, however, the curriculum needs to reflect appropriate responses to this. This means a curriculum that

prepares for responsible participation in a democracy in which public competence in ethical reasoning and moral responsibility complement the public understanding of science. In constructing such a curriculum, we need to be alert to the fact that, whilst there are regressive voices that desire, for whatever reason, to reassert the science of modernity, there are equally voices that call for regression in the field of ethics and morality. Blake (1997) demonstrates convincingly that much of the recent furore over the desire to include spiritual and moral development in the UK National Curriculum is rooted in a naive desire to regress to the imagined golden age of premodern ethics. The criticisms by SCAA (1995) of rational humanism associated with the Enlightenment have led some to argue that the response must be to rediscover or reassert what existed before the Enlightenment.

He continues to argue that ethical decisions about how we should live need a political dimension grounded in the reflexive analysis of risk and uncertainty. This is the reality for which the curriculum must prepare pupils. What might such a curriculum look like? Millar & Osborne (1998) have proposed significant changes to the science curriculum. They point out that many young people perceive the purpose of the scientific endeavour substantially in terms of its technological products, whilst remaining ignorant of the value and values of science outlined at some length earlier in this article. They are critical of the grounding of the present curriculum in the process of selection for higher study and argue instead for a curriculum, up to age 16, of general scientific literacy made accessible through what they call 'explanatory stories'.

By this term, they mean that science has an account to offer in response to questions such as 'How do we catch diseases?' It is possible, they argue, to answer such questions in accessible narrative form without degradation of the quality of scientific knowledge. They contend that a narrow focus on detail, further obscured by a numerical rather than narrative approach, has led to science education losing sight of the major ideas that science has to tell. They aim, amongst other things, to teach pupils why scientific ideas are valued and how scientific ideas underlie the rationale behind decision-making in such areas as personal diet, medical problems or energy use.

There are likely to be hazards in experimentation with a story-based science curriculum, however, not least because science is not the whole story. The precautionary principle is, after all, an acknowledgement of the limits of science. Ultimately, it needs to be clear to pupils where the boundaries of scientific knowledge and ethical responsibility in the face of uncertainty lie. Wittingly or unwittingly, the possibility of a subjective bias reflecting the culture or politics of the science storyteller is likely to be greater, and ultimately the authority of science thereby diminished.

Jickling & Spork (1998) have recently critiqued education for the environment, and their exposure of the degree to which practices akin to little more than indoctrination have become common is alarming. Some means of guarding against a passive approach in which the pupil is simply the recipient of the values and world view of the storyteller, however well intentioned, is needed.

Bishop & Scott (1998) argue for what they describe as scientific action competence. They draw on Brickhouse *et al*. (1993) in acknowledging that most school science is firmly rooted in positivistic philosophies with the consequence that little attention is paid to aspects of science education relating to the

development of competence. They quote the example of the development of a school compost heap in order to investigate the effect of moisture and nutrient input on the rate of compost production and the quality of the end product. They claim that, through this, the environmental problem of the waste of organic materials within the school is resolved, and that pupils can follow a formal scientific investigation.

The greatest potential of an action competency model is probably to be found in the way it creates the need for scientific knowledge to address a genuine environmental problem perceived by the pupils. Another example cited is the creation of a school wildlife pond, where scientific action competence is necessary to create a stable ecological community. There remains, however, a gap between school compost heaps and ponds, however worthy these may be, and global issues such as climate change.

That this gap needs some kind of bridging is illustrated graphically by new research currently under design at the University of the West of England, Bristol. In preliminary questioning of 11 year-old pupils about whether they will face any risks associated with global warming, 40.4% of respondents so far agreed that 'there might be a slight risk but that it's so far in the future it's not worth worrying about'. This compares with the next highest category where 36.1% rated that there is 'enough risk to justify everybody having good lessons about it at school'. Early indications of work with older pupils would seem to indicate that the first view is also likely to feature strongly in the thinking of these pupils.

How, then, can this challenge be addressed without reverting to crude behaviourism or largely discredited forms of moral persuasion through exaggerated threat? The approach currently under investigation at UWE is that of the development of pupil-scientist partnerships. The aim is to bridge the gap between 'school science' where, it would appear, the notion of truth possession and certainty would seem still to dominate the prescribed curriculum and the world of 'real science', where risk, uncertainty and limits to knowledge are increasingly regarded as the norm. If, in pursuing this goal, pupils are brought into contact with practising scientists and, through this come to the realisation that scientists themselves have moral principles and are frequently confronted in their work by ethical dilemmas, then steps towards a curriculum for reflexive modernity may well have been taken.

A priority in the UK identified by the New Labour Government, which came to power in 1997, is the linking together of schools, libraries and other educational organisations via a government-sponsored national computer network known as the National Grid for Learning. When universal access to this is achieved, highly significant technological developments such as 'new literacies' and a communicative capacity that brings the community of school pupils into a hitherto unimagined contact with the community of scientists may be achieved. The possibilities for the development of extended scientific action competence through partnerships between scientists and school pupils are exciting. A crucial difference between the original Habermas view of communicative competence (Habermas, 1984, 1987) and the emerging Beck view of risk society is the possibility of the emergence of the ethics of reflexive modernity through the creation of a new shared understanding. School pupils may not be able to halt the processes of climate change, but they will be able to participate in the process of setting priorities for adapting to climate change (Smith, 1997).

They will participate with their eyes open and they will know that global warming is not a problem for the generation after them but a responsibility they share with the community of scientists now. Perhaps then, their expectations of politicians will change, and the decline in political interest amongst the young that so troubled the authors of the Crick Report (Crick, 1998) will be reversed.

Conclusion

If the present National Curriculum is allowing significant numbers of pupils to grow up with the view that global warming is a problem far in the future which need not trouble them, then there is some doubt that these pupils are being prepared for adult life in the 21st century. Preparation for adult life in the 21st century has to include an element of risk literacy and an understanding of the limits of science. It also has to include an education in the philosophy, values clarification and citizenship skills that will be needed for competent and responsible participation in a risk society. Whilst writers such as Wynne (1992) usefully remind us, science has in the past been its own worst enemy in promoting the modernist cult of the technocratic managerial elite, the time has surely come to end any estrangement of science and environmental concern.

A new vision for a National Curriculum is needed. This will be a vision of a curriculum for a 21st century of reflexive modernity. It will not have much place for the yearnings for regression to modernity in science and premodernity in ethics that have characterised the closing decades of the 20th century. It will promote the public understanding of science and its limits as a vital function of effective and full democratic citizenship. It will use new communications technologies to forge friendships between the community of scientists and the community of school pupils. Through such new friendships it will develop the humility and respect towards the created world that the eco-radical community has sought for so long. There is no reason why socio-cultural sources of environmental concern as diverse as romanticism or religious belief cannot be part of this, for scientists can be romantics or religious believers as well as scientists. Perhaps, then, even the eco-radical community may one day be included in this new friendship.

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