

REVIEW ARTICLE

The Higher Moral Panic: Academic Scientism and its Quarrels with Science and Technology Studies

DAVID MERCER

Higher Superstition: The Academic Left and its Quarrels with Science

Paul R. Gross and Norman Levitt

Baltimore, Maryland, USA, The Johns Hopkins University Press, 1994, ix + 314 pp., AU\$55.00 (hbk), ISBN 0-8018-4766-4

ABSTRACT *'Higher Superstition' calls for scientists to symbolically take up arms against an anti-science movement (the academic left) which it claims has taken over a large part of the social studies of science, feminism, environmentalism and cultural studies. Despite its simplistic typecasting, unusually vitriolic and dismissive rhetoric and lack of interest in scholarly engagement with the fields of study under attack, 'Higher Superstition' has received considerable attention, much of it positive. It has become one of the most widely cited texts in the so-called 'Science Wars'. Numerous explanations for the emergence of such extreme claims and their positive reception have been canvassed. The lack of focus of the attack of the 'Science Wars' and the variety of explanations for its emergence suggests that the question of what constitutes an effective response from the humanities is a complex one and that the extreme 'Science Wars' rhetoric of texts such as Higher Superstition is unlikely to assist 'the sciences' address real issues in a substantial way.*

Keywords: Science Wars, social constructivism, anti-science, public understanding of science.

Introduction

One of the most distinctive features of the intellectual and cultural landscape of the second part of the 1990s has come to be the so-called *Science Wars*—the often very public attack by scientists of the images of science which appear widely in Humanities scholarship, especially Science and Technology Studies (STS). Gross and Levitt's *Higher Superstition* has become one of the most frequently cited texts in these so-called *Science Wars*. Because I am sure many readers will have already at least some familiarity with the *Science Wars*, I will review *Higher Superstition* itself rather briefly paying more attention to surveying the responses the text has generated and providing some propositions accounting for why it has stimulated such wide debate.

Higher Superstition calls for the rejection of the attitudes which Gross and Levitt believe the so-called 'academic left' holds toward science. The academic left can supposedly be identified by its uniform tone of hostility towards science. This hostility is not only towards the institutional and educational structures and mindset of scientists, but more pervasively (and perversely for Gross and Levitt), hostility towards the actual *content* of scientific knowledge itself. For Gross and Levitt, sympathies to social constructivist views of science (very broadly understood), whether they appear in history of science, cultural studies, feminism, science policy or environmentalism, and no matter what differences there may be on points of detail between such approaches, display an irrational 'muddleheadedness'. The possibility that the utility or creativity of various scientific achievements could be celebrated whilst embracing various forms of social constructivism, or that social constructivism is compatible with a wide divergence of approaches to science policy, is rejected out of hand.¹ Failure to accept the existence of a universal rational scientific method that leads directly to technological and social progress is interpreted as displaying a hostile anti-science attitude. For Gross and Levitt, such attitudes constitute part of the foundation of an expansionist post-modern ideology which tears away at the fabric of intellectual life and renders a relationship between the humanities and the sciences impossible.

One might expect such strong claims to be bolstered by a robust philosophical challenge informed by some awareness of the differences between the philosophical approaches and policy agendas of the wide variety of social constructivist influenced approaches to studying science and society. This is nevertheless not the case. Gross and Levitt ignore or are unaware of such debates. Apart from a chapter outlining the social/historical factors supposedly explaining the emergence of the academic left and repeated undeveloped general statements about the implausibility of anything but realist epistemology, Gross and Levitt devote their greatest energies to identifying points of 'scientific/factual' detail where they believe various representatives of the anti-science academic left have erred. Various *ad hominem* arguments are then used to suggest that such supposed errors² are frequently not only examples of scientific incompetence but ideologically driven intellectual bad faith. Gross and Levitt believe that the only reliable analysis of the nature of scientific knowledge comes from scholars like themselves who have 'subtlety', 'crudition' and the requisite professional scientific competence (p. 235). Because of their *a priori* beliefs in a universal rational scientific method they suggest that all social constructivist descriptions of science can be undermined by proper consideration of the underlying 'real' scientific facts. Studies of science, technology and society by definition then can only legitimately examine the effects of science on society not the effects society may have on the formation of the content of scientific knowledge.

Gross and Levitt pursue their critique with language that is arrogant, venomous and sarcastic. They justify their tone because of their belief that the academic left is spreading relentlessly, becoming entrenched in prestigious academic institutions, undermining the moral and intellectual fibre of Western intellectual culture and wasting precious funding that otherwise might be allocated to proper academic work.

Gross and Levitt suggest that scientists must start engaging in an active public critique against the 'unfocused bores' (p. 255) of the academic left, and science education must be vigorously policed against creeping anti-science incursions. Scientists should also be given the right to formally evaluate the quality of humanities scholarship which investigates science, including power over the hiring, firing and promotion of STS academics. Finally, there must be an attempt to recharge traditional scientific

approaches in disciplines such as anthropology and sociology which have been losing their way.

The timing of *Higher Superstition's* message would appear to have been cleverly judged. Similar sentiments have been voiced by some scientists since the early 1990s³ and there have been a number of 'spin offs' and local variations on Gross and Levitt's themes.⁴ Whilst a few reviews have been rather uncommitted in their appraisal,⁵ the much more common responses to *Higher Superstition* have been its understandable rejection by most historians and sociologists of science⁶ and its uncritical, enthusiastic embrace by scientific journals, pop science journals, and science journalists and commentators in the popular press.⁷ It is notable how many of the positive reviews have found *Higher Superstition's* uncompromising polemical tone infectious.⁸

More substantially, there has been evidence that scientists lobbying using Science Wars-styled rhetoric may have been an important factor influencing the withdrawal of offers of appointments to Bruno Latour and Norton Wise at the prestigious Institute of Advanced Studies at Princeton University. Allegedly the offers were withdrawn because the candidates were seen to have sympathies towards social constructivism.⁹ Winner has pointed out, nevertheless, that the suppression of academics for holding supposedly anti-science and technology views, or the 'wrong politics', has a history which pre-dates the recent Science Wars, probably the most widely known example being David Noble's well-publicised legal battles with MIT.¹⁰

Gross and Levitt's scorn has also been aided by the outrageous and well-timed 'Sokal Hoax'. Alan Sokal, a New York physicist, submitted a deliberate parody of the cultural studies of science to the journal *Social Text*. The journal went on to publish the paper without properly refereeing and rejecting it. The hoax led to wider publicity. Much of this has quoted *Higher Superstition* and taken the hoax as representative of declining academic standards in the humanities. The hoax raises some serious questions about the adequacy of the editorial processes of *Social Text*. But to draw the general conclusion that there are flaws in the rigour across all social science research from such a limited sample, itself, hardly represents good social science.¹¹

The main challenge to social and policy studies of science and technology constituted by *Higher Superstition* then, has been its role in nurturing a broader social movement which attempts to identify a tradition within such studies as a 'social problem'. Specific rebuttals on points of detail are unlikely to sway committed 'science warriors' constituting and policing science's boundaries. Once there is an essence of science and a clear opposing essence—the academic left—such boundary policing can be pursued with vigour.¹² *Higher Superstition's* deliberate failure to provide any detailed engagement with more specialised academic literature, including critics of social constructivism, makes it a difficult text to respond to on points of detail without embarking on a lengthy exercise trying to distil coherent argument from hyperbole. Readers wishing to survey debates surrounding the policy ramifications and philosophical viability of social constructivism would be better served by reading elsewhere.¹³

This leaves us with the question of why such an unbalanced polemical text which deliberately mocks scholarly engagement has captured the cultural moment? A number of overlapping explanations and related suggestions of how social constructivist influenced STS might mount a defence (I make no secret that I am writing from a position sympathetic to social constructivism) have appeared in the literature. I have identified five themes which frequently reappear. But given the volume and breadth of responses to the Science Wars, especially in electronic forums,¹⁴ the survey below should be taken as indicative rather than exhaustive.

The Science Wars as Part of a Broader Cultural Backlash Against the So-called 'Culture of Complaint', Post-modernism and Political Correctness

A number of social commentators have recently rallied against what is perceived as a crisis of confidence in the so-called traditional cultural and intellectual values of Western Liberalism. The 'special pleading' of interest groups is frequently targeted by criticism of affirmative action, multiculturalism, and claims that any kind of relativism leads to moral nihilism. *Higher Superstition* is peppered with many references back to these broader issues. In particular, Gross and Levitt would appear to link, to use Robert Hughes phrase, 'the culture of complaint'¹⁵ to what in more specialist academic terms have been described as 'standpoint epistemologies'(p. 33).¹⁶ To be able to link social constructivist influenced studies of science and technology to the problems and challenges raised by standpoint epistemologies Gross and Levitt have to homogenise often disparate bodies of literature and overlook the existence of lively debates surrounding the value of standpoint epistemologies and notions of post-modernity within the fields of discourse they criticise.¹⁷

For those who favour the interpretation that the Science Wars have piggybacked on this broader backlash there are no simple responses. Concerted effort to emphasise the diversity of philosophical approaches and policy agendas of social constructivist inspired studies of science is one alternative,¹⁸ but considering the growth of hostile Science Wars audiences who may re-appropriate criticisms within the field out of context, this is an alternative that needs to be pursued with care and clarity.¹⁹ An alternative possibility is that *Higher Superstition* may be engulfed by its own rhetoric. By identifying science as a special victim and displaying such a strong desire to silence critique and suppress alternative definitions of science, the sciences may appear to a 'tired' public as yet another selfish special-interest group. As Nelkin puts it:

At a time when academic institutions are generally under siege dividing the academy into warring factions in this way is extraordinarily counter productive, by defending themselves so bitterly against outside critiques, science can only reinforce the public image of their professions as arrogant and indifferent to public needs and answerable to no one. By sealing doors and closing ranks, they appear as simply another self protective institution looking out for interests and careers. And by making vociferous claims to absolute authority over the definition of truth, they are themselves behaving like fundamentalists.²⁰

The Intellectual Success of Social Constructivism Demanding a Response from Scientists

Contrary to the generally negative appraisals of the impact of the Science Wars rhetoric on the humanities, some commentators have emphasised their positive potentials. Some have argued that rather than interpret *Higher Superstition's* calls for the rejection of social constructivism literally and in isolation, they can be interpreted at a broader symbolic level, as indications that constructivist inspired social and policy studies of science are having an important impact on the broader academic culture. Scientific interest in this scenario is awakening because the field is now sufficiently well established to warrant a serious scientific response. One could anticipate constructive dialogue emerging as the 'rhetorical smoke' clears as scientists move beyond their caricatured misconceptions about the nature of social constructivism and learn to co-exist with their colleagues in the humanities.²¹ Consistent with this interpretation of the Science Wars, there have been

attempts to produce statements of the canon of social constructivist inspired social and policy studies of science and technology. Clearly articulating, to outsiders, the various intellectual positions making up the field and their points of conceptual convergence might be hoped to facilitate more constructive, better informed debate.²² Such a response may be flawed nevertheless by assuming that a social constructivist canon can be derived. Such deliberate professional boundary working may prove to be a tortuous process.²³

Communication Breakdown—or the Two Cultures Revisited?

Compatible in many respects with the above, yet another explanation has been that the Science Wars are largely a by-product of a communication breakdown between the sciences and the humanities, with fault on both sides. This environment has been a fertile one for the growth of extreme viewpoints which inhibit the development of constructive dialogue between the sciences and the humanities. Jardine and Frasca-Spada suggest that

... the participants should make proper efforts to inform themselves adequately of the others' disciplines. This is not just a matter of exponents of science studies taking care to avoid scientific errors of the kinds exposed by Gross and Levitt, of scientists acquainting themselves with the findings and theoretical frameworks of historians, philosophers and sociologists. Worthwhile conversation requires also sensitivity to other's norms of inquiry and communication.²⁴

Whether or not such dialogue can be created remains to be seen but the infectiously aggressive tone of *Higher Superstition*, which shows little sign of abatement, may make such pragmatic aspirations, whilst worthwhile, more difficult than proponents imagine.

The Battle over Who Gets to Define Science for the Public

Yet another explanation may well be traced to recharged debates on the importance of the public understanding of science. As social constructivist positions have matured they have expanded their influence into an increasingly wide domain of policy arenas, including the wider educational curriculum and broader culture. As social constructivist perspectives spread into such new domains there will inevitably be boundary disputes in relation to who speaks for science, and define what science is, to the broader public.²⁵ In this context it is no surprise that science and technology museums²⁶ and science education²⁷ have become sites for heated Science Wars conflict.

One response to *Higher Superstition*'s claim that social constructivism inspires public anti-science sentiments is for social constructivists to emphasise that by avoiding images of homogenous method defined science, anti-science sentiments may actually be avoided. For example, in public scientific controversies, social constructivist approaches provide valuable intellectual resources to help expose and explain the otherwise easily hidden value judgements and presuppositions which may be shaping scientific debate. In contrast, positivist alternatives such as those favoured by Gross and Levitt steer explanation towards acrimonious discourses such as scientific fraud and junk science.²⁸ By the failure to acknowledge the diversity of spaces for potential learning and accommodation between various branches of science and non-scientists, as well as the differentiation of styles of conflict and sources for scientific disagreement, Gross and Levitt may actually be contributing to the creation of spaces for 'wars' between scientists themselves, and scientists and the public. It can be added that by encouraging a sense of continuity between the sciences and other social activities and institutions, social constructivist

approaches encourage a more historically grounded image of the sciences. Public awareness of the historical/social contexts in which the sciences have grown also encourages an awareness that the sciences have not only experienced successes and consensus, but that failures, dead ends, and the existence of competing theoretical perspectives have also been common, and not a valid reason to hold anti-science sentiments. Alternatively, unfulfilled promises of the exaggerated benefits and naive images of the absolute objectivity of the scientific method constitute a simple target for public dissent and cognitive dissonance.²⁹

Contrary to *Higher Superstition* a robust relationship between scientists and the public may well rely on scientists and their audiences developing a greater sensitivity to the types of issues identified by social constructivist approaches.³⁰

As a By-product of Declining Science Funding

Other writers have noted that whilst much of the Science Wars seem to involve a contest of who controls the public image of science, it is ultimately the underlying question of scientific funding which has given the Science Wars their impetus. Following this model many scientists, particularly physicists as representatives of the exemplar of pure science, are suffering a case of *fin de siècle* funding blues as the last glimmers of government funded 'big science' decline with the close of the Cold War. Bruno Latour puts forward this case with a rhetorical flourish reminiscent of the style of Gross and Levitt:

A small number of theoretical physicists deprived of the fat budgets of the cold war, seek a new menace against which they heroically offer the protection of their *esprit* ... France in their eyes, has become another Colombia, a country of dealers who produce hard drugs—derridium and lacanium, to which American doctoral students have no more resistance than to crack.³¹

Contrary to Gross and Levitt's assessment, most social constructivist influenced challenges to positivist images of science say very little about what areas of science should, or should not, be funded, or the broader 'science budget'. In this context it is worth noting that it is extremely difficult to link the influence of social constructivist or post-modernist epistemology to declines in science funding and declining enrolments of students in science degrees. Policy approaches unsympathetic or indifferent to constructivism are the more likely source for impacts on the state of science funding. For instance, pressures for commercialisation and privatisation of research from the right, and critiques of the broader social usefulness and direction of research from the left. Targeting social constructivism as a scapegoat for broader structural change to the sciences is a convenient resource for science popularisers, such as Gross and Levitt, to evade the complexities of engagement with the more overt economics and politics of science. In this model, because the attack on social constructivism is dislocated from the real problems facing the sciences, it is possible that the extreme polemic of the Science Wars will, over time, 'run out of steam', transmuting into a more scholarly critique which will be absorbed into the body of existing debates about the 'pros' and 'cons' of social constructivism within the philosophy and social studies of science and technology.

Conclusion

From this brief survey it is clear that whilst the Science Wars defy simple explanations or solutions, the wider embrace of their sentiments by broader segments of academic and popular culture, especially self-appointed science popularisers, demands a response from

scholars in the humanities. Because of the breadth and bluntness of the attack contained in texts such as *Higher Superstition*, this includes those who have even minor sympathies to social constructivist perspectives, or are interested in developing almost any critical policy perspectives on science and technology. What *Higher Superstition* has failed to provide as a coherent scholarly challenge it has made up for with its timing and cleverly written infectious polemic. It is unfortunate, however, that its main achievement may have been to contribute to a pyrrhic victory of reinforcing intellectual divisions between the sciences and the humanities. To understand the diversity and complexity of scientific practices, develop strategies for the most socially and economically effective funding of scientific research, and answer the challenges of achieving a satisfactory relationship between the sciences and broader academic and non-academic communities, there should be careful consideration of the types of issues raised by social constructivist and other sociological and policy approaches to science. As edifying as it might be in the short term for science warriors to simplify the world as a showdown between the forces of good—science—and evil—the academic left—it is unlikely that the ‘sciences’ will benefit in the long term by rallying behind *Higher Superstition’s* polemic. Simplistic images of an imaginary world of anti-science and untrammelled scientific and social progress driven by scientific method, fail abysmally to provide the intellectual resources needed by the ‘sciences’ to respond to and successfully engage with the ‘real (social) world’.

Notes and References

1. See the special issue edited by Malcolm Ashmore and Evelleen Richards, Special Issue on ‘The Politics of SSK: Neutrality, Commitment and Beyond’, *Social Studies of Science*, 26, 2, 1996.
2. See R. Hart, ‘The flight from reason: Higher Superstition and the refutation of science studies’, in Andrew Ross (Ed.), *Science Wars*, Duke University Press, Durham, North Carolina, 1996, pp. 259–92. Hart identifies a number of places where Gross and Levitt have taken quotations out of context to bolster their criticisms.
3. Lewis Wolpert, *The Unnatural Nature of Science*, Harvard University Press, Cambridge, MA, 1992; G. Holton, ‘How to think about the ‘anti-science’ phenomenon’, *Public Understanding of Science*, 1, 1, 1992, pp. 103–28. For approval of Holton’s views but a call for even stronger rhetoric see J. Maddox, ‘Defending science against anti-science’, *Nature*, 368, 17 March 1994, p. 185.
4. For an Australian variation with an even more extreme epistemological ‘policing’ see Keith Windschuttle, *The Killing of History: How a Discipline is Being Murdered by Literary Critics and Social Theorists*, Macleay Press, Sydney, 1994. See also K. Windschuttle, ‘History must prevail against challenge of cultural studies’, *The Australian*, Wednesday 23 November 1994, pp. 32–33. For a discussion by Windschuttle citing Gross and Levitt’s ‘mission’ with approval see K. Windschuttle ‘Certain principles in hit and myth times’, Higher Education, *The Australian*, Wednesday 15 February 1995, pp. 25–26.
5. Richard Olson, for instance, calls for all parties to reflect on the different value systems they have brought with them into debate: R. Olson, ‘Whose is the higher superstition? Reflection on the need for sceptical open-mindedness in the days to come’, *Skeptic*, 4, 2, 1996, pp. 32–35. S. Weininger and J. Labinger ‘Conversing with outsiders’, *C&EN*, 73, 2, 9 January 1995, p. 27. Some other ‘milder’ overviews of aspects of the debate can also be found in ‘Science vs anti science?’, *Scientific American*, January 1997, pp. 96–101.
6. A good sample of negative appraisals of Gross and Levitt can be found in the collection edited by Ross, *op. cit.*; see also N. Wise, ‘The enemy without the enemy within’, *Isis*, 87, 2, 1996, pp. 323–27; B. Martin, ‘Social construction of an “attack on science” (review of Gross and Levitt, *Higher Superstition*)’, *Social Studies of Science*, 26, 1, 1996, pp. 161–72.
7. A large number of positive reviews can be found, for a sample see, H. Bauer, ‘Higher Superstition: the academic left and its quarrels with science’, *Journal of Scientific Exploration*, 8, 4, 1994, pp. 555–63; W. Herbert, ‘The PC assault on science’, *US News and World Report*, 20 February 1995, pp. 64–65.

- For a good example of the mimicry of Gross and Levitt's extreme polemical style see R. Sandell, 'Science and superstition', *Engineering World*, June 1995, pp. 19–22.
8. J. Cribb, 'Call to counter age of anti-science', 'Higher Education', *The Australian*, Wednesday 18 October 1995, p. 12.
 9. D. Bereby, 'That damned elusive Bruno Latour', *Lingua franca*, September/October 1994, pp. 22–32, 78; C. Macilwain, 'Science Wars blamed for loss of post', *Nature*, 387, 22 May 1997, p. 325.
 10. L. Winner, 'The gloves come off: shattered alliances in science and technology studies', in Ross, *op. cit.*, pp. 106–7.
 11. S. Hilgartner, Discussion Paper, 'The Sokal affair in context', *Science Technology and Human Values*, 22, 4, 1997, pp. 506–22.
 12. T. Gieryn, 'Comment and reply: policing STS: a boundary-work souvenir from the Smithsonian Exhibition on "Science in American Life"', *Science Technology and Human Values*, 21, 1, 1996, pp. 100–15.
 13. Ashmore and Richards, *op. cit.*; Martin Hollis and Steven Lukes, *Relativism vs Rationalism*, Blackwell, Oxford, 1982.
 14. P. Hert, 'Social dynamics of an on-line scholarly debate', *The Information Society*, 13, 4, 1997, pp. 329–60.
 15. Robert Hughes, *The Culture of Complaint: The Fraying of America*, Oxford University Press, New York, 1993.
 16. 'Standpoint epistemologies' emphasise the local and situated construction of knowledge and the weaknesses in assuming any common standards of rationality. Political variations of these themes have emphasised the idea that the knowledge acquired by oppressed minorities and women has the possibility of being more authentic as it has not been knowledge developed to merely service the dominant status quo.
 17. Judy Wajcman, *Feminism Confronts Technology*, Allen and Unwin, North Sydney, Australia, 1991, pp. 8–12; E. Richards and J. Schuster, 'The feminine method as myth and accounting resource: a challenge to gender studies and social studies of science', *Social Studies of Science*, 19, 1989, pp. 697–720.
 18. M. Elam and O. Juhlin, 'When Harry met Sandra: an alternative engagement after the Science Wars', *Science as Culture*, 7, 1, 1998, pp. 95–109.
 19. See for example, P. Cole, 'Voodoo sociology: recent developments in the sociology of science', p. 283, and P. Gross, 'Introduction', see note 4, pp. 6–7, in Paul R. Gross, Norman Levitt and Martin W. Lewis (eds.), *The Flight from Science and Reason*, The New York Academy of Sciences, New York, distributed by the Johns Hopkins University Press, Baltimore and London, 1996.
 20. D. Nelkin, 'The Science Wars: responses to a marriage failed', in Ross, *op. cit.*, pp. 121–22.
 21. See C. Macilwain, 'Campuses ring to a stormy clash over truth and reason', in 'Briefing Science Wars', *Nature*, 387, 22 May 1997, p. 331. For an example of a more sophisticated and less inflammatory exchange between a scientist and social constructivists see, J. A. Labinger, 'Science as culture: a view from the petri dish', and responses by H. M. Collins, S. Fuller, D. Hakken, W. Keith, M. Lynch, H. M. Marks, T. J. Pinch, A. Stockdale and J. A. Labinger, 'Reply', in *Social Studies of Science*, 25, 1995, pp. 285–348.
 22. N. K. Hayles, 'Consolidating the canon', in Ross (ed.), *op. cit.*, pp. 226–37.
 23. 'The theory landscape in science studies: sociological traditions 95–110', in 'Part II Theory and Methods', in Sheila Jasanoff, Gerald E. Markle, James C. Petersen and Trevor Pinch (eds.), *Handbook of Science and Technology Studies*, Sage, Thousand Oaks, CA, 1995.
 24. Nick Jardine and Marina Frasca-Spada, 'Splendours and miseries of the science wars', *Studies in the History Philosophy of Science*, 28, 2, 1997, p. 234.
 25. E. Masood, 'Gunfire echoes in debates on public understanding', in 'Briefing Science Wars', *Nature*, 387, 22 May 1997, pp. 331–35. See also L. Wolpert, 'Woolly thinking in the field', in 'Risk in a Modern Society, Special Supplement', *Times Higher Education Supplement*, 31 May 1996, p. viii. See also response, A. Irwin and B. Wynne, 'Lessons at the sharp end', *Times Higher Education Supplement*, 21 June 1996, p. 13.
 26. T. Geiryn, *op. cit.* See also, P. Gross, 'Reply', *Science Technology and Human Values*, 21, 1, 1996,

- pp. 116–20. See also editorial in *Nature* in relation to Smithsonian display, 'Science in American Life', 380, 14 March 1996, p. 89.
27. Compare D. C. Phillips, 'Coming to grips with radical social constructivisms', with W. A. Suchting, 'Reflections on Peter Slezak and the sociology of scientific knowledge', pp. 151–95, in Michael R. Mathews (ed.), 'Special Issue on Philosophy and Constructivism in Science Education', in *Science Education*, 6, 1–2, 1997.
28. For a discussion of the political uses of accusations of junk science as a device to attempt to prematurely close debates in areas of scientific disagreement, see G. Edmond and D. Mercer 'Trashing junk science', *Stanford Technology Law Review*, 3, 1998 (http://sclr.stanford.edu/STLR/Articles/98_STLR_3).
29. S. Fuller, 'Science and end to history, or history to science', in Ross, *op. cit.*, p. 45.
30. Alan Irwin, *Citizen Science*, Routledge, London, 1995. See David Mercer, 'Science, technology and democracy on the STS agenda: review article', *Prometheus*, 16, 1, 1998, pp. 81–91.
31. B Latour, 'Y-at-il une science après la guerre froide?', *Le Monde*, 17 January 1997, quoted in Jardine and Frasca-Spada, *op. cit.*, p. 222.