The Democratic Control of the Scientific Control of Politics

Matthew J. Brown

Abstract I discuss two popular but apparently contradictory theses:

T1. **The democratic control of science** – the aims and activities of science should be subject to public scrutiny via democratic processes of representation and participation.
T2. **The scientific control of policy**, i.e. **technocracy** – political processes should be problem-solving pursuits determined by the methods and results of science and technology.

Many arguments can be given for (T1), both epistemic and moral/political; I will focus on an argument based on the role of non-epistemic values in policy-relevant science. I will argue that we must accept (T2) as a result of an appraisal of the nature of contemporary political problems. Technocratic systems, however, are subject to serious moral and political objections; these difficulties are sufficiently mitigated by (T1). I will set out a framework in which (T1) and (T2) can be consistently and compellingly combined.

1 Introduction

The relationship between science and democracy has been of increasing concern to a variety of fields, including STS, policy studies, environmental studies, and philosophy of science. There are a variety of issues and approaches, but there are two main lines of concern: first, whether and in what sense science is or ought to be political – especially whether it ought to be democratized; second, determining

M.J. Brown (✉)
Center for Values in Medicine, Science, and Technology, The University of Texas at Dallas, 800, W. Campbell Rd, JO 31, Richardson, TX 75248, USA
e-mail: mattbrown@utdallas.edu

V. Karakostas and D. Dieks (eds.), *EPSA11 Perspectives and Foundational Problems in Philosophy of Science*, The European Philosophy of Science Association Proceedings 2, DOI 10.1007/978-3-319-01306-0_39,

the role of experts in democratic society – how to deal with their authority versus democratic equality, how to render their role more productive and reliable. My goal will be to explore a way these two lines might converge.

I will consider two theses that are each frequently defended and individually compelling (though by no means uncontroversial) but apparently at odds:

T1. **The democratic control of science** – some of the aims and activities of science should be subject to public scrutiny via democratic processes of representation and participation.
T2. **The scientific control of policy**, i.e. **technocracy** – political processes should be problem-solving pursuits determined by the methods and results of science and technology.

I will not attempt to satisfactorily argue these theses independently, though I review some prominent defenses of them, hopefully demonstrating their plausibility. It is enough for my purposes that there is significant interest and support in these claims to wonder about whether they are consistent. Despite the tension between the two – (**T1**) points to an increasing role of the non-expert public, while (**T2**) points to an increase in expert control – they can be combined in a coherent way. I propose that we can make sense of this combination by treating science and politics as parallel and mutually involving processes. I will sketch a framework for such an understanding science and politics, which I will call "*democratic technocracy*."

2 Why Democratize Science?

There are many arguments for increasing democratic participation in science, especially those areas of science that have an impact on politics and public life. In none of those arguments does "democratizing science" amount to simply replacing evidence with votes.[1] These arguments include purely epistemic arguments, from those depending on purely formal results like the Condorcet Jury Theorem or Diversity-Trumps-Ability Theorem, to Mertonian or pragmatist arguments that democracy is a fundamental requirement of the epistemic structure of science. Rather I will emphasize two ways that we can show the need for democratizing science: based on the social status and role of science and based on the role of values in science.

According to the first type of argument, our current apolitical image of science accords it a high degree of *both* social *authority* and social *autonomy*.[2] A conflict arises when according any institution *both* authority and autonomy to such a great

[1] Anderson (2007) covers several of these sorts of arguments.

[2] Because the focus is on science in its role in the public, especially policy, and not in the abstract, what is at issue cannot be merely epistemic authority, if that is understood in a way that is irrelevant to social authority.

degree. As Heather Douglas puts it, "[A]n autonomous and authoritative science is intolerable . . . A fully autonomous and authoritative science is too powerful, with no attendant responsibility" (Douglas 2009, pp. 7–8). An authoritative institution compels respect or exercises power over some aspect of social life, while an autonomous institution is not influenced by or responsible to anything beyond its own internal norms. An institution that is both authoritative and autonomous creates an unacceptable tension for a democratic society, which is apparent from the types of institutions ordinarily have these roles.

Social authority is a feature of public institutions, such as legislatures or the police; in democratic societies, the legitimacy of that authority depends *inter alia* on that institution being democratically representative, authorized, and accountable. These democratic responsibilities may take many different forms, but an authoritative institution cannot have legitimacy without them.[3] On the other hand, social autonomy is a feature of private pursuits, traditions, or ideologies, so long as they do not cause harm to non-members or the public interest. The only autonomous sphere is the private one, and private beliefs, practices, or associations do not have any special authority in a democratic society.

The analysis of authority and autonomy thus depends on the distinction between public and private. Following John Dewey in *The Public and Its Problems* (1927), an issue is *public* if it has significant consequences for people beyond those directly involved in and responsible for it; it is private otherwise. A more contemporary term for such consequences is *negative externalities*. We can say that *matters of public interest* arise as groups of people are impacted by the consequences of activities in which they do not participate, recognize those effects, and articulate them as such. The impacted group we call a *public*. By contrast, purely private concerns only affect those who are direct parties to the activity.

By definition, if a practice or institution is socially/politically *authoritative* in some realm, then it has consequences beyond those who are engaged in the practice or constitute the institution; it is a *matter of public interest*. Such practices or institutions *should not be* autonomous, at least in a democratic society, because they will then be immune from the sorts of checks that give their authority *democratic legitimacy*. It is a minimal requirement in democratic societies that the affected parties have a voice on matters of public interest.

Thus, the attempt to combine authority and autonomy in our treatment of science creates a serious conflict. As Douglas points out, those who have responded to that conflict (e.g., Feyerabend, the sociology of scientific knowledge) have tended to challenge the "most obvious" part of this tension: *authority* of science (2009, p. 8).[4] Challenging the authority of science amounts to weakening or denying the existence of expertise in politics. This requires us to give up tools in policy-making that we

[3]The type of "authority" in question concerns the voice that experts *qua* experts have over and above ordinary citizens in policy deliberations. The authority of those policies, once adopted, is a separate issue.

[4]E.g., Feyerabend, *Against Method*, (1975, p. 299).

cannot do without, and, given the remarkable success of science, seems absurd in any case (Douglas 2009, p. 8). While science studies work concerned with this tension has been unduly trying to undermine the *credibility* of scientific experts, they should have been questioning the "*legitimacy* of existing norms of cooperation" between experts and the public (Bohman 1999, p. 591). Challenging the autonomy of science amounts to requiring that science be responsive to and guided by public interests and recognize its democratic obligations.

A second approach to the democratization of science comes from the *value-ladenness of science* defended by feminist philosophers of science among others. It is increasingly difficult to deny that social values necessarily play a role in scientific activity at some level. Values might enter in to several phases of scientific inquiry: e.g., choice of research agenda, methodology, proposal of hypotheses, testing and confirmation, or application. Various theorists have given accounts of the way values work in each stage. For example, Kitcher (2001) focuses on the way that values ought to guide the research agenda of science, determining which projects are significant and ought to be prioritized. Douglas (2000) focuses instead on the role of values in validation of theories and hypothesis, specifically on the role they play in guiding decisions about uncertainty (such as what false positive and false negative rates to accept). Kourany (2010) gives an argument grounded in feminist philosophy of science for strong ethical standards and social responsibilities in every aspect of science. Longino (1990, 2002) is concerned with the role of values in guiding background assumptions and the need for pluralism and critical debate in the social structure of science.

If it is true that values play a necessary role in practice of science, then to the degree that the science has consequences for the public interest, public interests ought to be represented in those value-judgments. It would be inappropriate for scientists as a group to impose their value judgments on the public, in a democratic society, when their value judgments have repercussions for the interests and welfare of the public (Douglas 2005, p. 156). Douglas argues that not only must scientists be explicit about how values are used in making judgments, but also that they must actively democratize their work in a deep way in order to work responsibly.[5]

3 The Scientific Control of Politics

The argument for increasing the role of expert control in politics and policy-making depends on an assessment of contemporary political problems and the way they have been handled in democratic societies. Governing by non-expert opinion doesn't work for contemporary political problems: the problems are too technical, such

[5]Douglas's own approach is largely based on models of participatory democracy and the "analytic-deliberative" model set out in *Understanding Risk: Informing Decisions in a Democratic Society* (Stern and Fineberg 1996). My alternative approach will be laid out in Sect. 4.

that non-expert control is extremely unlikely to provide adequate solutions. Most citizens have only a dim view of what is going on in many of the central political problems of the day. Many current policy proposals are too complex for the public or any non-experts to meaningfully evaluate. One need only listen to commentaries on most major legislation to see that few actually understand the *content* of the proposals in question.

Can representative democracy ameliorate this problem? This is, after all, why we elect representatives, who we are supposed to trust to make these decisions in our stead. They can devote themselves to understanding the issues, with the help of their sizable support staff, and so respond appropriately. In practice, things do not work out so well. From issues of climate and environmental science to medicine and healthcare to economic and monetary policy, many prominent and powerful politicians show themselves to be incompetent to deal with the issues.[6]

Some have gone so far to argue that the reaction of the public and the behavior of politicians on these issues constitute a *failure of democracy*. A1 Gore has said with respect to the policy response to climate change:

> Global warming has been described as the greatest market failure in history. It is also—so far—the biggest failure of democratic governance in history. (Gore 2009, p. 303)

Gore attributes lack of progress he sees towards dealing with the problem of climate change to problems with democracy itself. Environmental scientist James Lovelock has gone even further and suggested that we may need to temporarily suspend democracy to adequately address the problem.[7] If democracy is going to be able to handle the complex and technical problems of contemporary society, its relationship with expertise is going to have to be reconfigured. It no longer seems to be the case that we can rely on non-experts to make the final evaluation in such cases.

The problem is, however, deeper and more fundamental. This is because even political problems that *seem* to be non-technical *actually* require technical expertise for adequate solutions. Indeed, the sort of problems we're more ready to turn over to politics *without* consulting expert opinion may in fact be the most complex and technical. Many of the most controversial political debates are conducted *not* on the basis of clashes of fundamental values, but rather they turn on questions of what will *work*, i.e., the most effective resolution of a problem.

Consider the recent debates about health care policy reform in the United States, which have a long history but have been especially at the forefront of political debate since the debate and passage of the Patient Protection and Affordable Care Act in 2009 and 2010. While there are certainly a number of controversial questions of

[6]Recent exchanges over monetary policy between U.S. Congressman Ron Paul and Federal Reserve chairman and economic expert Ben Bernanke are a particularly evocative version of this. See, e.g., http://www.theatlantic.com/business/archive/2011/07/bernanke-to-ron-paul-gold-isnt-money/241903/

[7]See also Mark B. Brown, "Is Climate Change Good for Democracy," Center for Values in Medicine, Science, and Technology, September 2011. http://www.utdallas.edu/c4v/mark-b-brown-is-climate-change-good-for-democracy/

values with respect to health care policy – is it a right or a private service? how does economic efficiency trade off against the welfare of the disadvantaged? – these are not the top points of controversy in the discussion amongst the public, in the media, and in the political arena. Concerns instead focused on questions like: How much will the reforms increase access? How much will the reforms cost? These are factual questions about the cause and effect relationship between implementing a policy and various results. We want to know, *given* aspects of the problem to be solved, whether the policy will solve it (or make it worse) and to what extent. Many of the questions involve knowledge of the current healthcare system, economics, actuarial science, tax policy, etc.

This is a very general feature of political debate. Without minimizing the importance of conflicts over values, much political controversy turns around complex *factual* questions. On welfare, we wonder whether a policy will spur or discourage job-seeking; whether it will provide enough for the recipients to live on; whether they will be able to game the system. On taxes, whether it will generate enough revenue to cover current spending; whether various groups will pay more or less; whether it will be more efficient. On economic stimulus, whether it will work to bring various economic indicators up in a certain amount of time.

Much political controversy centers around factual questions about whether policies will work to meet stated goals, to solve problems of public interest. But whether some policy will work is not settled by value judgment. Nor does there seem to be compelling evidence that whether a policy will work is well-tracked by public opinion or policymaker judgment. In order to make these determinations, evidence must be gathered and evaluated. Models may need to be constructed, tested, and applied. Consequences may need to be monitored and further revisions considered.

In other words, often what is necessary in political problem-solving is the kind of expertise and inquiry that has proven effective in the sciences: evidence-based, systematic, experimental. This does not necessarily mean that what we need are experienced scientists or technologists – what we need is the same *kind* of expertise but applied to a different subject matter. Policy should be directed by those who are experts *at solving political problems*.[8]

4 Putting the Two Together

The two claims that I have discussed are apparently incompatible:

(T1) tells us that science should be controlled democratically – guided by the public.

[8]Philosophers who have objected to the idea that policy should be directed by experts will be addressed in Sect. 5.

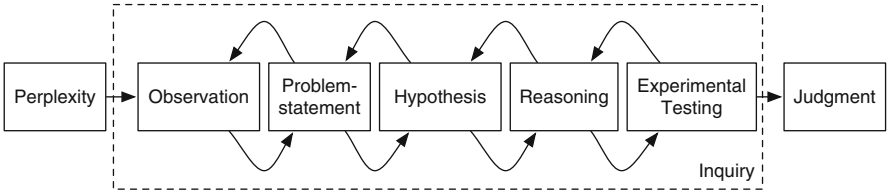

Fig. 1 The pattern of inquiry according to Dewey (Simplified)

(T2) tells us that policy should be decided by expertise and scientific inquiry, not by non-experts – so apparently, not democratically.

The tension arises when our interpretation of (**T1**) is guided by our ordinary conception of democratic politics and (**T2**) by a traditional conception of science. Our ordinary conception of democratic politics puts prime emphasis on public opinion, discussion, and votes. Our ordinary conception of science is technical, value-free, and distant from political engagement.

The two claims can be coherently combined by thinking a little differently about the nature of both science and democracy. As Bohman (1999) says, "both democracy and science must be transformed" in light of their interaction (p. 591). We should regard the *central* process of politics as *inquiry*, in precisely the same sense of 'inquiry' as the central process in science and technology, governed by the same sorts of methods and norms. On the other hand, as explored in Sect. 2, the norms governing science include *not only* considerations of evidence and reasoning, but also democratic and ethical obligations. We scientize political inquiry only after we democratize our conception of scientific inquiry. Call this approach to reconciling these claims *democratic technocracy*.

We can bring out the parallels between science, technology, ethics, and political action by thinking about *inquiry* much as John Dewey did,[9] as an experimental problem-solving process, beginning with a state of perplexity and concluding with a judgment that resolves that perplexity. Inquiry on Dewey's account consists of functionally defined, reciprocally connected phases (Fig. 1). The phases Dewey describes are not surprising or controversial, but what is important is that each phase stands on a par with the other phases as necessary functional components of an recursive process aimed at the resolution of a problem. The upshot is that the adequacy of any component of inquiry faces two tests: compatibility with the other phases of inquiry, and the ability of the whole to produce a judgment that resolves the initial perplexity. Dewey combines these two features under the term "functional fitness" (Dewey 1938, p. 114).

[9]The theory of inquiry was a major concern throughout Dewey's career, including works such as *Studies in Logical Theory* (1903), *How We Think* (1910/1933), *Essays in Experimental Logic* (1916), and *Logic: The Theory of Inquiry* (1938).

In the context of this project, another useful feature of Dewey's account is that the same pattern applies to any type of inquiry: to research in physics, to medical diagnosis, or to choosing a climate mitigation policy. This works because it is a relatively open interpretive framework – it does not overgeneralize from specific features of physics. The framework still has significant normative bite, however. For example, given that evidence is produced as a functional component of an inquiry in the context of solving a particular problem, evidence produced in one inquiry cannot be taken for granted in an inquiry in a very different context. Most "evidence-based policy" guidelines make that mistake, of taking the validity of evidence across contexts for granted; this is one of the (many) reasons such guidelines are incomplete or flawed.

Inquiry of any kind becomes democratized in at least two ways. First, there can be public input into the different phases of inquiry. For instance, there may be situated knowledge that inquirers must aggregate in order to better understand the situation – as when farmers, environmentalists, and those living downstream may have information about the use of a fertilizer in a particular locale that laboratory and field scientists may lack access to. And as in Sect. 2, there is also a major role for public input about value-judgments in the various stages of inquiry. One practical example of such a democratized framework for inquiry is the analytic-deliberative method of *Understanding Risk* (Stern and Fineberg 1996, pp. 16ff, especially p. 28).

This framework shows that democratized inquiry requires a thorough interweaving of scientific-technical experts, political actors, and interested publics. Such analytic-deliberative frameworks may not be feasible or appropriate in all cases. The inquiry may be more removed from the experience of non-experts, may be so technical that the public is unable to engage fruitfully, or they may be long-term inquiries in which direct and meaningful participation is unworkable. In some situations, public participation and deliberation may be counter-productive (Jasanoff 2003). We can democratize inquiry in a second way by having the expert inquirers themselves acting as representatives of the public.

I am not merely suggesting that scientists should act "in the public interest." Indeed, in this simple formulation, many would say this is precisely what scientists do: by engaging in pure research, scientists act in the public interest in advancing and communicating knowledge. Rather, it means that inquirers in democratized inquiry have the same responsibilities to the public as other public officers: legislators, judges, police, bureaucrats, etc., i.e., the responsibility to democratically represent the public, a complex set of activities including, "authorization, accountability, participation, deliberation, and resemblance"(Brown 2009, p. 8).

For example, scientists could be *authorized* by bodies like the National Academy of Sciences but in ways that would assess not only their technical proficiency but also their social responsibility. Their work could be held more *accountable* if they had to make explicit the role of values in their decision-making for scientific debate and public scrutiny (Douglas 2009, p. 173). And they could help increase *resemblance* by ensuring that the scientific community does not systematically exclude any demographics in society or simply by consciously and explicitly considering a variety of social perspectives (Brown 2009, pp. 228–231).

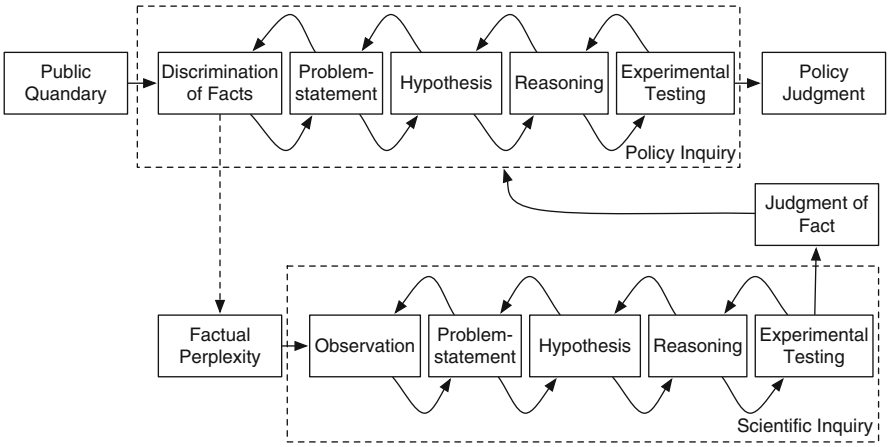

Fig. 2 Policy inquiry spurring scientific inquiry de novo

Turn now to the case of policy inquiry, which I have suggested can be captured by the same pattern of inquiry. The *perplexity* that spurs the inquiry in that case is a *public* quandary, as opposed to a merely private issue. The perplexity is a *matter of public interest* that must be articulated in a participative and democratic process. Policy-making is a response to such problems, a form of inquiry aimed at their resolution. It may be one in which integrating competing value-claims is as important as determining the facts, but all the same it is a form of inquiry.

Policy inquiry remains a rather broad category. In some cases, relatively unstructured and ad hoc public groups can engage in cooperative inquiry leading to a policy judgment. But in the sort of political problems and public quandaries discussed in Sect. 3, much more structured and systematic approaches are necessary, including reliance on the organized institutions of science and government. A central role must be played by a new form of expert: experts at conducting policy inquiry. At the same time, a large role remains for the public – but the same sort of role imagined for the public in the case of science that bears on matters of public interest. In many cases, scientific experts will also play a role in cooperation with policy experts and the public.

In the case of democratized policy inquiry, perplexities of fact may arise that require scientific inquiry *de novo* (Fig. 2). Indeed, the need for gathering new evidence, solving new problems about what is going on and *what* causal structures exist that can be made use of is a pervasive need in modern political practice.

While sometimes knowledge exists prior to the policy inquiry in a pre-packaged form, in general, the political context frames new scientific inquiries. Because inquiry is a contextual problem-solving process, this framing is the only guarantee that the results of scientific inquiry will be relevant and adequate to the political task.

In the case of scientific inquiry spurred and framed by a policy inquiry, we can see how this model treats science and policy-making as both mutually involving and also parallel processes. Both follow the same basic pattern of inquiry. Policy inquiry not only makes use of the results of past inquiries and the methodological lessons of scientific inquiry, but also may spin off scientific inquiries that can respond directly to the problems of fact that it raises. These inquiries are not only framed by the policy issue, but they must be democratically responsible in precisely the same ways that policy inquiries must be.

Jasanoff (2009) spoke hopefully of the place of science in the new administration in the U.S. that it might accept "the essential parallelism between scientific learning and democratic learning." The framework of *democratic technocracy* provides a way of recognizing that parallelism and resolving many of the difficult problems where science and democracy meet.

5 The Threat of Technocracy Ameliorated

There are many objections to technocratic governance that have made it seem an unpalatable response to the sort of problems raised in Sect. 3, and which may be taken to cast doubt on *democratic* technocracy. To the contrary, the framework sketched here ameliorates all of the serious problems with technocracy.

First, technocracy is associated with "The pursuit of technical perfection for its own sake" (Mitcham 1997, p. 263). A common theme among philosophical critics of technology, coming from otherwise diverse points of view, is that the increase of technology brings along with it a focus on efficiency or instrumental rationality to the exclusion of all human values and ends. It should be clear that these sorts of problems do not apply to the framework of democratic technocracy. Democratic technocracy begins with quandaries that are *matters of public interest*, not with purely technical problems or problems defined by the experts.

A second problem with technocracy is a result of the special status accorded to experts. Expert rule as traditionally conceived confronts the problem of the experts themselves ceasing to be agents of the common good and instead becoming a distinct ruling class serving their own interests. Dewey (1927) was concerned to combat this form of bare technocracy (see especially pp. 364–5). These are precisely the problems that the *democratization* of technocratic inquiry is meant to solve. According to the framework of democratic technocracy, every kind of inquiry with public ramifications must be democratized, must involve either public input into the stages of inquiry or democratic representation on the part of the inquirers. Furthermore, the democratic obligations of inquirers increase as their work becomes more a matter of public interest. In the case of policy inquiry, such obligations are paramount. The proposed democratic interactions and representative obligations would prevent policy experts from becoming a specialized class.

Turner (2001) addresses several political problems of the role of experts in a democratic society, including the idea that experts pose a threat to democracy

because "expertise is treated as a kind of possession which privileges its possessors with powers that the people cannot successfully control, and cannot acquire or share in" (p. 123). But this is not the case in democratic technocracy's conception of expertise. According to the account laid out above, policy experts must be accountable in that they must inquire into quandaries that are genuinely matters of public interest, their value judgments must be subject to public input and oversight, and the public must even share in the production of knowledge and policy where doing so will help solve problems more effectively. Both scientific and policy experts must be accountable and responsible in these ways in part to avoid Feyerabend's worry that "science education" become "a form of state propaganda" (Turner 2001, p. 124; Feyerabend 1978, pp. 73–76).

Finally, a common response to technocratic governance is that it overestimates the power of expertise and scientific inquiry to manage complex social systems. But if we do not use the knowledge and methods of our most powerful tools of inquiry to control these complex systems, what shall we do instead? Leave it up to haphazard fortune? To public opinion? In the face of public problems, we can either do nothing (on the conservative principle that any attempt to fix things is likely to make it worse) or we can try to do something to ameliorate the problem. If we choose the latter, then we should use all of the resources of intelligence at our disposal, including the knowledge and methods of science and technology.

6 Conclusions

I have argued that two significant and often defended (if controversial) theses – (**T1**) that science ought to be controlled and accountable to the public and (**T2**) that policy ought to be controlled by the methods and results of science and technology – can be coherently combined into a compelling framework. This requires transforming our understanding of science to be a value-laden practice and of politics to be a form of problem-solving inquiry, a view I have called *democratic technocracy*. I elaborated the view by connecting it with Dewey's theory of *inquiry* – the common denominator between science and politics.

This essay leaves open many pressing issues of the relation of science to democracy. It does not begin to address, for example, the question of which types of public participation and deliberation (consensus conferences? citizens' juries?) serve to help or to hinder scientific expertise in policy-making. Instead, it addresses a fundamental question about the relation of science and democratic politics that lie at the root of such questions. Nevertheless, the framework I have provided for understanding that relation significantly reorients thinking about these issues with many concrete ramifications for specific issues.

We need to think about the jobs of scientists and policy-makers as overlapping, rather than wholly distinct ones to be treated separately by the policy process. Policy-makers ought to be a kind of technical experts, proficient at directing policy inquiry and bringing effective judgment to public quandaries. On the other hand, we

should recognize that scientists (potentially) have responsibilities as representatives of the public (Brown 2009, pp. 14, 259). Science should be thought of as a public trust (Dewey 1939, p. 170), not just in the sense that in many places, most scientists are professors at public universities, but in the sense of expressly pursuing the public good and being public accountable for it.

Of course, these points go not only for the work of policy-relevant scientific experts, but also for the parallel work of policy experts. We should think of policy as Dewey did, as an experimental, cooperative inquiry aimed at resolving problems of public interest. While real conflicts will arise, and the need for "politics" in the traditional sense will never go away, shifting the center of gravity of policy-making away from the clash of ideology and public opinion toward the cooperative enterprise of solving shared problems may help to resolve pressing contemporary problems of science and politics.

References

Anderson, E. (2007). The epistemology of democracy. *Episteme: A Journal of Social Epistemology, 3*(1), 8–22.

Bohman, J. (1999). Democracy as inquiry, inquiry as democratic: Pragmatism, social science, and the cognitive division of labor. *American Journal of Political Science, 43*(2), 590–607.

Brown, M. B. (2009). *Science in democracy: Expertise, institutions, and representation*. Cambridge, MA: MIT Press.

Dewey, J. (1903). *Studies in logical theory*. Chicago. University. The decennial publications (2d ser., Vol. XI). Chicago: The University of Chicago press.

Dewey, J. (1916 [2007]). *Essays in experimental logic*. Carbondale: Southern Illinois University Press.

Dewey, J. (1927[1986/2008]). *The public and its problems* (The later works of John Dewey, Vol. 2). Carbondale: Southern Illinois University Press.

Dewey, J. (1933 [1986/2008]). *How we think: A restatement of the relation of reflective thinking to the educative process*. (The later works of John Dewey, Vol. 8). Carbondale: Southern Illinois University Press.

Dewey, J. (1938 [1986/2008]). *Logic: The theory of inquiry*. (The later works of John Dewey, Vol. 12). Southern Illinois University Press.

Dewey, J. (1939 [1986/2008]). *Freedom and culture*. (The later works of John Dewey, Vol. 13). Southern Illinois University Press.

Douglas, H. (2000). Inductive risk and values in science. *Philosophy of Science, 67*(4), 559–579.

Douglas, H. (2005). Inserting the public into science. In S. Maasen & P. Weingart (Eds.), *Democratization of expertise? Exploring novel forms of scientific advice in political decision-making* (Sociology of the sciences yearbook, Vol. 24, pp. 153–169). Dordrecht: Springer.

Douglas, H. (2009). *Science, policy, and the value-free ideal*. Pittsburgh: University of Pittsburgh Press.

Feyerabend, P. K. (1975). *Against method: Outline of an anarchistic theory of knowledge*. London and Atlantic Highlands: New Left Books.

Feyerabend, P. K. (1978). *Science in a free society*. London: New Left Books.

Gore, A. (2009). *Our choice: A plan to solve the climate crisis*. Emmaus: Rodale.

Jasanoff, S. (2003). Technologies of humility: Citizen participation in governing science. *Minerva, 41*(3), 223–244.

Jasanoff, S. (2009). Essential parallel between science and democracy. *Seed Magazine*. http://seedmagazine.com/content/article/the_essential_parallel_between_science_and_democracy. Accessed 16 June 2012.

Kitcher, P. (2001). *Science, truth, and democracy*. Oxford: Oxford University Press.

Kourany, J. A. (2010). *Philosophy of science after feminism*. Oxford: Oxford University Press.

Longino, H. E. (1990). *Science as social knowledge: Values and objectivity in scientific inquiry*. Princeton: Princeton University Press.

Longino, H. E. (2002). *The fate of knowledge*. Princeton: Princeton University Press.

Mitcham, C. (1997). Engineering design research and social responsibility. In K. Shrader-Frechette & L. Westra (Eds.), *Technology and values* (pp. 261–278). Lanham: Rowman & Littlefield.

Stern, P. C., & Fineberg, H. V. (Eds.). (1996). *Understanding risk: Informing decisions in a democratic society*. Washington, DC: National Academies Press.

Turner, S. (2001). What is the problem with experts? *Social Studies of Science, 31*(1), 123–149.