SCIENCE EDUCATION & PUBLIC POLICY

Laboratories in a Democracy: Science and Hard Public Policy

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Abstract

Attaining the SENCER ideals of teaching basic science through public issues that are "complex, contested, and unresolved" and identifying the limits of science in helping us "decide what to do" can be facilitated by appreciation and analysis of the political pressures within the policy making process itself. Science and government depend on each other, but scientific facts and evidence do not have an inevitably sure path into the policy process. Strongly held and conflicting human values are reflected in contesting political interests that can have the power to shape the reception for scientific facts and evidence in the policy process. Outright rejection of facts, disputes over science-policy boundaries, and alternative framing of issues all help to explain the uncertainty that frequently awaits science in the policy process. The highest attainment of SENCER ideals lies in understanding both science and policy making as shapers of the future.

Introduction

Scientists in the trenches of their work know that doing inventive and worthwhile research taxes mind, body, and spirit. Supporting funds always seem to be scarce, false starts are distressingly common, pressure to publish can be unrelenting, experiments can resist sure replication, colleagues may be uncooperative, and flashes of understanding can be frustratingly elusive. Despite the frustrations, however, hard work and persistence, brilliant insight, and sometimes a bit of serendipitous luck can produce findings that literally change the world. But why is it so hard for government to produce related public policy, particularly when the findings of science have so much to offer? Why is debate over climate change, nuclear waste disposal, evolution, vaccination, embryonic stem cell research, and environmental strategies so durable? Why do governments have such difficulty deciding on public questions, especially when answers informed by science seem so obvious to so many?

These questions lurk in the core of the statement of SENCER ideals. Why are public issues that we use to reach and teach basic science "complex, contested, and unresolved?" Why does the enormous power of science that helps us to understand have such limits in helping us as a polity decide what to do? And why is the SENCER alert to "multidisciplinary

trouble" so liberating as we try to engage students in our individual disciplines? Getting students to appreciate the rigors and wonders of basic science through the prism of public issues may have the ironic and welcome consequence of getting them to appreciate the rigors and wonders of public policy as well.

A Durable Interdependence

The relationship between science and government has a venerable history going back to the nation's founding. Among the powers the framers at the Philadelphia Convention of 1787 granted to Congress in the Constitution was the power "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." During the nineteenth century Congress created the Smithsonian Institution, land-grant colleges (now universities), the National Academy of Sciences, and the U.S. Geological Survey, all institutions that to this day continue to make scientific contributions to the nation. World war, the space race, and political demands for better health intensified this relationship between science and public policy in the twentieth century, as the Manhattan Project, NASA, civilian nuclear power, and a growing budget for the National Institutes of Health attest.

Science and government clearly need each other because neither can do its work without the contributions of the other. Researchers depend on government as the principal source of the funds that scientific investigation requires. As one example of this dependence, preliminary data indicate that the federal government in 2008 was the source of almost sixty-one percent of all funding for basic research done in universities and colleges, about three times more than the institutions themselves provided for basic research (U.S. NSF, 2010). The scope of such federal support for academic research is acknowledgement that without the contributions of science government literally cannot accomplish its missions, including developing advanced weaponry, exploring new energy sources, and finding cures for disease. Harvey Brooks neatly captured this close interrelationship between science and public policy by his classic conceptual formulation of "policy *for* science" and "science *in* policy" (1964, 76, emphasis added).

A timeless expression of the relationship between science and government at its best is the contribution of truth to power. In this model vision, knowledge guides power and is vitalized by it while simultaneously avoiding the potential impotence of science and potential mindlessness in public policy. Without political power to apply research results in public policy, truth in the form of scientific findings risks the impotence of having little impact in the larger society. At the same time, public decision making without the truth of scientific findings risks mindlessness in policy with potentially dire consequences for the larger society.

As the work of scientists and policy makers seeps into the work of the other, attempts to assess appropriate and mutually beneficial relationships between the two have long engaged science policy scholars. In a book chapter aptly titled "The Spectrum from Truth to Power," Don K. Price defines four sets of institutions or "estates" that must relate to each other in the making of public decisions: the scientific, the professional, the administrative, and the political. According to Price, the scientific end of the spectrum pursues "knowledge and truth" and the political deals with "power and action" (1965, 135). Each of the estates contributes to and respects the work of the others. But Price asserts that while scientists are "deeply involved in the major issues that confront a modern government…it is not easy to define the ways in which scientists should be given support by government and permitted to exercise their initiative or influence in policy issues of interest to government" (275). Alvin Weinberg posits the concept of "trans-science" to capture policy questions that are informed by science but cannot be definitively answered by it, necessitating broader public participation in ultimate decisions (1972a). For example, as nuclear scientists cannot guarantee the absolute safety of nuclear reactors and the disposal of radioactive waste, the broader society, with as much information as science can provide, must decide final policy questions on nuclear power and the risks it carries (1972b, 34).

Roger A. Pielke, Jr. focuses on scientists themselves and the various roles they can choose to play in the policy process. Pielke identifies these roles as pure scientist, science arbiter, issue advocate, and honest broker of policy alternatives (2007, 1-7). This spectrum of roles opens to scientists different paths to pursue, from explaining research findings themselves (pure) to answering questions about policy alternatives (arbiter) to pressing for a particular policy (advocate) to exploration of alternatives to broaden and enlighten the choices policymakers confront (broker). Pielke sees dangers to scientists who advocate particular policy positions because such advocacy threatens what he sees as the fruitful role for scientists in assuming the role of honest broker (135). Rather than similarly positing particular roles to scientists, Ann Campbell Keller

in her analysis of science in environmental policy argues that the capacity of scientists to shape policy outcomes becomes more constricted as the policy process moves from the setting of agendas to the more formalized stages of legislating and implementing policy by executive agencies (2009, 13-14, 170). As the stakes in the policy process rise and final decisions come closer, scientists increasingly encounter the sharp edges of competing interests that rigorously press for their own policy ends.

Science has demonstrably produced enormous public goods, even though the relationship between scientists and policy makers has been troubled by conflicts both over which science fields should receive tax money support and the public uses to which the fruits of science should be applied. But the conflicts between science and public officials have perhaps never been greater than they have been at the beginning of the present century. Exploring why politics and science can be a combustive mixture and why the political world may be so resistant to findings of scientists can help to explain why so many public issues are contested, complex, and unresolved, an exploration that is in the true spirit of the SENCER enterprise.

Empiricism and Political Power

Scientists and public officials as discrete groups engage in fundamentally different kinds of work, with each profession having different goals, different skills and talents, different sets of pressures, and different standards of success than the other. The goal of science is "understanding nature" (Kranzberg 1968, 21), a purpose that researchers pursue through empirical investigation of the world about us. Scientists collect data, discern what is fact and what is not, mount experiments to test relationships, and develop theories to explain how facts fit together and how and why the part of the world they are studying actually works as it does. Scientists observe and, guided by evidence and theoretical constructs, explain. Their success is gauged by the replicability of their experimental findings and the fit of the facts to their theoretical explanations, as determined by rigorous review by their peers and publication of results for wide dissemination. In a seminal interpretation in the history of science, Thomas Kuhn instructs us that this process is subject to conflict and perturbation as new paradigms replace the old (1962, 156-158). But at the core of their work, scientists see themselves as guided by the search for understanding, no matter where the search leads. A powerful ingredient in the potentially combustive brew of science and politics is that this search sometimes risks leading to places where some people do not want to go.

While science seeks to understand, the ultimate goal of government and the political process is the making of public policies, highly diverse in ends such as protecting individuals from each other, exploring the solar system, preventing epidemics and finding cures for disease, running massive educational systems, increasing agricultural yields, and anticipating and coping with disasters resulting either from natural forces or human agency. As statutes, taxes, and regulations exemplify, government is the only institution in society that can make rules applying to everyone or requiring behaviors of particular classes of people or organizations.

The very gravity of this responsibility means that whatever government does or plans to do is ordinarily subject to intense scrutiny accompanied by either strong support or powerful opposition, depending on the interests of those affected by the government action. What do people or groups want, that is, what are their *interests*? For example, do they want a tax on fossil fuels to limit carbon emissions and global warming, or do they oppose such a tax because of its threat to the fossil fuel industry? In addition, do contesting groups have the capacity or political strength to get what they want? That is, do they have the *political power* to get Congress and the president to approve a fossil fuel tax as law or, alternatively, do their opponents have the political power to get Congress and the president to reject a fossil fuel tax? These questions about interests and the political power to advance interests lie at the heart of political conflict and the success or failure of individuals and groups in that conflict.

Conflict in the Making of Public Policy

Clashing judgments of what government should or should not do are a distinguishing characteristic of the policy process. At the time of the nation's founding more than two centuries ago and in a call to accept the new constitution the framers proposed, James Madison in *Federalist* No. 10 addressed an essential truth in human experience that the operation of government cannot escape:

> The latent causes of faction are thus sown in the nature of man; and we see them everywhere brought into different degrees of activity, according to different circumstances of civil society. A zeal for different opinions concerning religion,

> concerning government, and many other points, as well of speculation as of practice….So strong is this propensity of mankind to fall into mutual animosities that where no substantial occasion presents itself the most frivolous and fanciful distinctions have been sufficient to kindle their unfriendly passions and excite their most violent conflicts. But the most common and durable source of factions has been the various and unequal distribution of property.… (Shapiro 2009, 48-49).

The passage of centuries has changed the policy questions but not the fact of conflict itself.

As great literature and multidisciplinary attempts to plumb the human psyche demonstrate, no single explanation can capture why people disagree with each other in politics or any other realm of experience. According to political scientists, we get our perceptions of politics through a process of political socialization in which parents and families, teachers and schools, and peers are among the powerful shapers of our views of politics and policy. These shaping influences will differ in strength and direction from one individual to the next. In a provocative and intriguing analysis, some political scholars argue that political attitudes may have a genetic basis that compels consideration of the inheritability of genes interacting with environmental influences to shape political orientations (Alford, et.al. 2005). Demographic characteristics like education and income level, occupation, race, age, gender, and religious commitment lead to different life experiences that produce conflicting judgments on what government ought to do. These political differences can be like quicksand for scientific findings making their way into the policy process. The laboratory is tranquil compared to the cacophony of voices synonymous with the political struggle to get government to do some things but not others.

In debates that have racked the nation over the last decade and more, the fact of political conflict has enormous implications for science in public policy in substantive areas as diverse as biotechnology, public school curricula, climate change, and environmental strategies. Life scientists have high hopes for the therapeutic potential of research on stem cells derived from human embryos (IOM 2002, 34-36). But religious convictions that human embryos are lives deserving of protection (On Embryonic Stem Cell Research 2008) have embroiled federal funding of such research in controversy. Religious fundamentalists have refused to accept evolution (NAS/IOM 2008, 37-39), the organizing principle that explains changing life on the planet, because it violates their belief in the inerrancy of the Biblical account of creation. This rejection of evolution as an explanation has produced fights over how public school curricula should address pedagogy in biology (Kitzmiller 2005).

Among other powerful contestants of scientific findings in the shaping of public policy are economic self-interest and occupation. Research results that a chemical may be carcinogenic, or that a medical device may harm more than help, or that fossil fuels may change climate are all economically menacing to industries relying on such products. Creating a memorable quotation with very contemporary resonance, Upton Sinclair wrote "It is difficult to get a man to understand something, when his salary depends upon his not understanding it!" (1994, 109). The conflict between economic interests and scientific findings is nowhere more evident than in the political battle over strategies to cope with climate change. What seems obvious to the vast majority of climate scientists is threatening to the fossil fuel industry. The scientific consensus among climate researchers is that the earth is warming, in particular because of an increase in carbon emissions from the use of fossil fuel (NRC 2010, 27-28). However, the fossil fuel industry has vehemently argued in opposition that legislative efforts to limit carbon emissions will incur unacceptably high costs to consumers and the industry (API 2009).

In the high stakes of making public policies, government is essentially attempting to shape what the future will look like on a given issue. That different individuals and groups have alternative visions of what they think the future should look like lends public policy making its fascination, frustration, and importance. As individuals and groups contest with each other, government must make choices among alternative futures. Should we embark on a manned mission to Mars, or not? Should we levy taxes on carbon use to limit global climate change, or not? Should we use federal funds to support embryonic stem cell research, or not? Should we bury spent nuclear fuel in Yucca Mountain, Nevada, or not? Should we limit Environmental Protection Agency regulation of wetlands, or not? Government has the unique power to determine public policy by making such choices, with inevitably differential consequences for different individuals and groups. In Aaron Wildavsky's phrase, *policy politics* engages the question, "which policy will be adopted?" (1966, 304).

Government power to select from among alternative futures and make specific policy choices naturally invites unrelenting efforts by individuals and groups within and outside

of government to shape government's ultimate decisions to their self-interests. Efforts to get government to choose specific policy futures can take a variety of forms, including working toward electoral victories or defeats of specific candidates, making cash campaign contributions to political candidates taking favored policy positions, lobbying officials directly, or engaging in policy argument to persuade others of the rightness of a particular point of view through a variety of media avenues, including speeches, commercial advertisements, and claims of specific interest cloaked in the guise of analysis. The fact of government power to make binding decisions invites, if not demands, these intensive efforts to persuade. A key question is the role that science plays in what is the struggle of persuasion that political power attracts.

Science in Policy Argument: Rejection, Boundaries, and Framing

Science has demonstrated enormous power to create basic knowledge about how the world works and has, consequently, fundamentally shaped many public policies, from national security to public health to agriculture. But depending on the policy area at issue, the transfer of scientific findings to the consequence of public policy can be halting and circuitous or perhaps even overtly impeded. To the chagrin of those seeing knowledge as the great clarifier in policy disputes, evidence and facts do not openly speak for themselves or lead to inevitable outcomes, especially when evidence is uncertain or seems to threaten other interests. Where contending interests are vigilant and the stakes are high, science can confront a variety of neutralizing strategies that include outright denial of facts inconvenient to an opposing interest, disputes over the proper boundaries between science and politics, and alternative framing of issues, all courses of action that enrich understanding of why public issues can be complex, contested, and unresolved.

The policy debate over vaccination and autism illustrates the power of passionate beliefs to reject science when it conflicts with those convictions. A 1998 medical article linked the rising rates of autism to childhood vaccines, setting off a storm of controversy about vaccination policy. Other researchers have since repudiated the article's findings, but to no avail in quelling the controversy. In groups accepting the linkage despite the repudiating research, the proclaimed desire to protect children and a suspicion of medical elites have combined to reject scientific findings that unreservedly find no link between autism and vaccines (Specter 2009, 57-101). Rejection of scientific facts has also occurred at the highest levels of government. In 2004 the Union of Concerned Scientists issued a sharp critique of the administration of President George W. Bush for suppressing or distorting scientific evidence in the implementation of public policy in a variety of areas, including climate change and air quality, in the service of political purposes and ends favored by the administration (UCS 2004). Frontal attacks on the truth of scientific findings are the clearest example of the surprisingly inhospitable reception scientific facts can sometimes get in the policy process.

Another category of reception science may receive in the policy process is not outright rejection but dispute over where science ends and where policy begins. The lines of demarcation between the two are not sharply delineated, however, particularly when scientific uncertainty meets policy options riven with value conflicts (Jasanoff 1987, 196-97). Controversies springing from government regulation of environmental and carcinogenic substance risk exemplify these boundary disputes and the role contesting interests play in defining the boundary. Sheila Jasanoff clearly articulates the stakes in these conflicts:

> [W]hile no one doubts that science should be done by scientists and policy by policy-makers, the problem for each interest group is to draw the dividing line between science and policy *in ways that enlarge its own control over social decisions*. Competition among these groups leads to differing definitions of the point at which the autonomy of science ends and the role of decision-making begins. (1987, 199-200, emphasis added)

Jasanoff analyzes disagreements between regulating agencies and the affected industry over, for example, the relative importance that should be attached to positive and negative studies of carcinogenic substance risk in the construction of regulations. Emphasis on positive studies would more likely lead to regulations detrimental to the chemical industry, which predictably claimed that ambiguity of findings should not be the basis for policy (205-11). Illustrating the crucial role that political interests play in the struggle to define the line between science and politics, industry pressed "to remove risk assessment from the control of agency scientists and bureaucrats, whom industry regarded on the whole as captive to pro-regulatory interests" (210). Jasanoff's research finds

that once consequential policy decisions are in play, just what constitutes actionable scientific findings becomes part of the political argument.

Finally, beyond outright rejection and boundary disputes, science making its way into policy must cope with how public issues affected by science are framed and how they are received by interested participants in the process. Though framing is defined in different ways by different disciplines, Shanto Iyengar argues that "In operational terms…researchers have converged on a relatively loose definition of framing as information that conveys different perspectives on an issue" (2010, 188). Linked to the process of persuasion, framing is the "way in which opinions about an issue can be altered by emphasizing or de-emphasizing particular facets of that issue" (Iyengar and McGrady 2007, 219). Scientists try to persuade their peers through the publication of data and the replicability of experiments. In the broader arena of the policy process, however, persuaders use policy argument to try to get their way, and framing of issues in the service of specific interests is an example of policy argument that buffets the movement of data and experimental results into the policy arena.

The multiple surfaces of public issues can reflect the light of facts and information in a variety of ways, sometimes directly and sometimes obliquely revealing the purposes of the framers who define issues to mirror their interests. Global warming can be framed as an environmental crisis demanding attention, or as a dangerous ruse that will end up devastating traditional industries and their jobs; embryonic stem cell research as work potentially leading to life-saving therapies, or as heartless killing of innocent embryonic life; civilian nuclear power as an environmentally friendly fuel free of carbon emissions, or as an environmentally dangerous producer of long-lived toxic waste; child vaccination policy as a bolster to community health, or as the bearer of illnesses like autism; government mandates requiring health insurance as a way to disperse health care costs more fairly, or as a threat to the fundamental freedom from government that should protect against such coercive mandates.

Framers of public issues clearly want to shape public attitudes for any of the motivations common to human behavior, from preserving or promoting economic self-interest, to protecting and disseminating strongly held religious beliefs, to advancing specific ideological views that either cloak or openly celebrate particular economic values or belief systems. But the process is complicated by the findings of cognitive scientists that human brains are not simply blank slates or empty vessels that are written on or filled by external persuaders (Mooney 2010). Rather, we as individuals have cognitive frameworks that filter and process the vast amounts of information we receive to make it comprehensible or palatable or safe for us. That we are not blank slates is a fact that complicates the movement of scientific facts from laboratories to public policy.

George Lakoff argues that the Enlightenment view that facts and evidence will inevitably convince us if we are simply open to them must be replaced by a more accurate and textured view of how we reason, "reason incorporating emotion, structured by frames and metaphors and images and symbols, with conscious thought shaped by the vast and invisible realm of neural circuitry not accessible to consciousness" (2008, 14). Matthew C. Nisbett and Chris Mooney write that individuals use "perceptual screens" made up of "value predispositions (such as political or religious beliefs)" as they assess and interpret the information they confront. This perceptual screening explains the sharp partisan differences between Democrats and Republicans on whether humans are primarily responsible for global warming, partisan differences that exist despite the nearly unanimous scientific judgment that human activity plays a crucial role in creating the condition of warming (2007, 56).

Dan M. Kahan and his colleagues make a similar argument that the distribution of scientific facts must be accompanied by awareness that "cultural cognition strongly motivates individuals—of all worldviews—to recognize such information as sound *in a selective pattern that reinforces cultural predispositions*" (2010, 30-31, emphasis added). Cultural values can include a defense of commerce and industry, or an acceptance of the need for government regulation, or a celebration of individualism, or, alternatively, equality, or support for civilian nuclear power. Depending on the predispositions of individuals, cultural values like these will shape individual receptivity to scientific information, in the form of acceptance, skepticism, or outright opposition. Kahan and his colleagues, for example, argue that individuals amenable to the value of support for commerce and industry are likely to reject information on global warming as threatening to their values if resulting policy risks more government regulation. But they are likely to be more receptive to the information if they see global warming as affirming a value they support, such as the

need for expansion of carbon-free nuclear power (2010, 31). The facts of science become more powerful convincers if persuaders recognize and acknowledge the very human values at stake in the persuasion.

Sensitivity to such human values in the communications process is crucial for scientists who hope their research findings will shape public policy. Ensuring that laboratory work makes a difference in the larger society requires attention to the audience that scientists must reach (Nisbet 2010, 41). Scientific facts about medicine and health, for example, can touch people in a more direct way if they are accompanied by personal narratives that demonstrate the power of evidence for individuals. As an illustration, specific accounts of illnesses in others caused by children who are not vaccinated can accentuate the persuasive power of scientific evidence confirming the need for vaccination (Meisel and Karlawish 2011, 2022). A burgeoning literature on the process of communicating science argues that successful transfer of information beyond the laboratory must acknowledge the special characteristics of media channels and the values and needs that move potential recipients of the information (Kahlor and Stout 2010, Russell 2010).

Public Policy and SENCER Ideals

In the drive to discover, to understand, to make connections among apparently unrelated phenomena, the scientific enterprise has been among the noblest expressions of the human spirit. The results have been astounding creations of ingenuity, from genetic modification of plants to increase agricultural yields, to the identification of cellular development to cure disease, to peeling away the dense layers of structural complexity in the cosmos to advance our comprehension of the universe. But the demonstrations of ingenuity have brought problems as well, from the unfathomable destructiveness of weapons, to threats to strongly held beliefs, to disturbances to powerful economic interests. The drive of the human spirit in science brings with it consequences that are often disparate and sometimes disconcerting. Science takes us to new places that are inviting to some and uninviting to others, a fact that is central to the relationship between science and public policy.

If they do anything, the findings of science change what the future will look like, in medicine, in agriculture, in national security, in our perceptions of the problems we face. But politics and public policy, too, like science, are expressions of the human spirit. They, too, have as their ultimate purpose the definition and determination of what the future will look like in particular policy areas. Since both science and public policy each in its own way essentially shapes the future, the interaction between the two, depending on the science and the issue, can produce mutual cooperation or sharp conflict. Whenever science touches deeply held human values, like protection of livelihood, or religious belief, or ideological predisposition, or fundamental sense of self, the facts of science can face a rocky terrain in the policy making process. Among the implications of new knowledge is that its dissemination cannot escape the very human trial of deciding how to proceed in the face of disagreement.

Doing basic science is hard and taxing work, though the truths it establishes about the world around us are intellectual treasures and bulwarks of our survival. But science and scientists, even when the evidence they produce is unambiguous, cannot make our policy choices about the future for us. The policy process in a democracy is often messy, frustrating, and even petty, but it is through that process, imperfect as it is with sharp value conflicts and power inequalities, that we ultimately decide the kind of future we want. The SENCER ideal of teaching basic science through "complex, contested, capacious, current, and unresolved public issues" simultaneously captures both the pursuit of truth in science *and* immersion in the human struggle to shape the future through the policy process. As researchers and teachers, we cannot ask for more.

About the Author

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