10. The Salience of Secular Values and Scientific Literacy for American Democracy

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The Congruence of Science and Secularism

Embedded in modernity is the idea that science is a major building block of the secular worldview, and that the progress of science is, *de facto*, the triumph of the secular worldview. This outlook arises from the close historical, philosophical, and intellectual relationship between the natural sciences and secular ideas and values. Both secular and scientific values were entrenched within the Enlightenment project of emancipating humanity and actualizing the highest human potentials through the diffusion of knowledge. These goals, in turn, became linked to the quest for liberty, freedom of thought, and popular sovereignty—and thus democracy. The triadic relationship of secular values, scientific literacy, and social and economic progress, and their role as the building blocks of democracy in the United States, is the subject of this chapter. Our purpose is to demonstrate that particularly in the 21st century, in order to achieve a prosperous society and a healthy, participatory democratic order based on secular values, a high degree of science literacy among the citizenry is necessary.

There are indeed many points of congruence between the scientific and the secular, including commitments to reason, skepticism, systematic knowledge, empiricism, and the procedural aspects of scientific methodology—all of which form the basis of a common commitment to the impartial generation of truth. The methodical use of empirical data in scientific research accords with the "worldly" focus of secular ideas and values. Modern science is thus properly considered an agent of secularization because of its association with free inquiry and freedom of thought and expression. It also qualifies by virtue of its role in undermining the superstition, ignorance, and belief in magic that so often fostered fear and authoritarianism in human societies.

The Scientific Revolution of the 17th century involved an unprecedented endeavor to secure the autonomy of the scientific enterprise from religious authority. It established core methodologies that investigators use when they experiment, when they confirm what others have done, when they follow through on the processes of not only generating but testing, confirming, and denying knowledge of one sort or another. This cultivation of a naturalistic worldview and a skeptical spirit encouraged believers and non-believers alike to cultivate a new mental habit of demanding good, empirically verifiable reasons for their beliefs, and to reexamine the factual basis of moral causes. These pioneers envisioned science as a powerful force for social progress.

It was the proponents of Copernicus' theory of a heliocentric universe who began using the phrase *libertas philosophandi* (freedom of philosophizing—free inquiry). This term eventually found its way into the full title of Spinoza's famous *Theological-Political Treatise* of 1670. Galileo proclaimed the fundamental scientific principle that "Two truths cannot contradict each other." In 1660, when the famous Royal Society of London was founded, its members asserted that science was based on the principle of testing ideas by experiment, adopting as their motto "*Nullius in verba*," which, loosely translated, means, "Take nobody's word for granted." They also went on to commit themselves to exclude matters of religion and politics from scientific discussions. In a similar vein in *The Federalist No. 10,* U.S. founding father James Madison[1] warned of the danger passions and factions posed to freedom. By "passions," he meant impulses such as irrationality and demagogy, and by "factions" he meant special interests. Since suppressing and controlling the creation of groups (i.e., regulating the right of association) was against freedom, the best check was a democratic impulse that encouraged voluntary and civic organizations in the Enlightenment-based hope that reason would prevail and extreme and fringe groups would remain just that: marginal, on the fringe. The vehicle for achieving this experiment was the theologically neutral secular state.

The sciences, in terms of their ethos and organization, can also be viewed as the best example of the triumph of the essentially secular ideas embodied in the French Revolution's slogan of *liberté, égalité, fraternité*, and its promise of *la carrière ouverte aux talents*—meritocracy. With its universality, objectivity, and commitment to meritocratic peer review, science seems to admit of egalitarianism and real democracy more than any other area of human enterprise. Its ethos leads to a universalism of good ideas and empirical data that are accepted from whatever quarter they emerge.

Science involves an anti-authoritarian tradition since it is based on the concept of self-generated human progress—constantly reforming and refining itself from within, without external guidance. In the words of the sociologist Max Weber,[2] science is a secular "vocation" and "scientific work is chained to the course of progress…; every scientific 'fulfillment' raises new 'questions'; it *asks* to be 'surpassed' and outdated." In the 20th century, modernist authoritarian movements such as fascism and communism lauded science and invested heavily in it. However, these regimes were ambivalent in their embrace of science, for they still expected science and scientists to be subservient to, and even to buttress, the ruling political ideologies. This led to state-endorsed pseudo-science such as "race theory" and eugenics in Nazi Germany,[3] and Lysenkoism in the Soviet Union.[4]

Today, scientific education and research are commonly viewed as pillars of secular lifestyles and social organizations that, as a matter of principle, reject the authority of any particular religious association or ideological doctrine. Along the lines of Isaiah Berlin's[5] celebrated distinction between "negative" and "positive" conceptions of liberty, science and secularism can thus be seen as congruent because of their common endeavor to demarcate areas of human action that are "free from" external, particularly religious, authority.

Science Education

The interplay of science education and secular values has long been recognized as having public policy importance in a number of areas—particularly with respect to economic prosperity and geopolitical strength. The pivotal role that education plays in fostering labor productivity and, by implication, economic growth—not just as an input linking aggregate output to the stock of productive inputs but also as a factor strongly associated the rate of technological progress—was acknowledged from the time of the Industrial Revolution. In the United States, the dream of harnessing scientific progress to the betterment of all citizens arose during the Progressive era in the early 20th century—the heyday of belief in the public school and the birthplace of the research university. The Progressive idea of universal education and progress, exemplified in the writings of John Dewey, and earlier by Horace Mann, was predicated on the notion that the form of education that can truly empower individuals is scientific in spirit and principle. This idea was originally propagated by a coalition of industrialists, public servants, and academicians who believed that science and its universal method of knowledge acquisition could unify the nation and generate economic and social progress.

This vision assumed that science was and should be value-neutral and indifferent to the varied identities and beliefs of an increasingly diverse American nation. The Progressives professed that the "indifference" of science—its disinterested search for truth—was basic to its credibility and strength.[6] Yet in our time this ideology, which conceives of science as a common good embodying value-neutral knowledge, has come to be disputed by certain communities that feel threatened by the implications of scientific research for their own worldviews. In the academy, a fashionable relativist and postcolonial outlook belittles the achievements of science and instead valorizes "local knowledge" grounded in indigenous or ancient conceptual categories. More importantly, science has come under challenge from a resurgent religious fundamentalism, which above all seeks to protect young people from being taught scientific ideas that seem to threaten religious beliefs.

Paradoxically, the very triumph of science has enhanced its vulnerability to these forms of "skepticism." As it has advanced and grown, science has become more complex and less easy for ordinary people to comprehend. In an age when technology is increasingly user-friendly, it is easy to be indifferent, alienated, or hostile to the scientific enterprise while indulging in the benefits of science-based high-tech industry. Burkhardt[7] has alluded to the widening gap between the scientific community and much of the general public. This intellectual and social divide has gradually eroded the status of science as a common good. Even though most Americans still claim to value science highly and believe it will continue to make their lives better, too many steer clear of it in school. As a result, the traditional model of science education now appears to have become less functional. Although parents recognize that their children's future depends on a good education, the swell of scientific illiteracy prevents them from assessing with confidence and clarity what actually constitutes a good education.

U.S. Educational Performance in Science

It is not too much to say that in the contemporary U.S., the dream of science education for all has become an empty cliché rather than a source of personal inspiration. The result is a mood of ambivalence and confusion among many American science educators. One cause of the negative trend outlined above can be seen in the most recent international comparisons of performance in science among 15-year-old students. The Program for International Student Assessment (PISA) [8] run by the Organization for Economic Co-operation and Development (OECD), a 30-member-nation body, reported that the U.S. rated below average in science and mathematics. On student performance the U.S. mean score is 489 (Finland is top with 563), which is significantly lower statistically than 20 other countries, including its main European and Asian economic competitors such as Canada, Japan, Korea, U.K., Germany, and Hong Kong. PISA felt it necessary to comment that "Countries below the trend line, such as the United States, show lower performance than would be predicted from their GDP per capita." This is not a matter of under-investment in education. Quite the reverse: "Spending per student in Czech Republic and New Zealand are 41% and 57%, respectively, of the spending levels of the U.S. but both are among top performers in PISA." Moreover, American students show as much general interest in science, enjoyment of science, and motivation to learn as in other countries. We have to ask whether there is a cultural or pedagogic problem in science education.[9]

Another statistic from PISA suggests American education has problems of a class nature that require a response from policy makers. PISA performance patterns vary widely across countries. For example, Korea is among the best-performing countries in science in PISA 2007, in terms of students' performance, while the United States performs below the OECD average. Nevertheless, the United States has a similar percentage of students at the top at Levels 5 and 6 (9.1%) as Korea (10.3%). The discrepancy in mean scores between the two countries is partly accounted for by the fact that at the lower levels of proficiency (that is, below Level 2) the United States has 24.4% of students, while Korea has only 11.2%. Across all participating countries students' general appreciation of science is positively associated with their socio-economic background. PISA reports that "This relationship is most pronounced in Ireland and the United States." U.S. official data is confirmatory; the National Assessment of Educational Progress report on urban school districts showed that urban schools where minorities are concentrated lagged badly behind on scientific literacy.[10] These findings validate the statement made earlier concerning a divide between a scientific elite and the general public. In the contemporary U.S. there is a social gap that equates to a knowledge gap in science literacy. When a well-educated, prosperous liberal elite is estranged from the bulk of the population, it is a serious political and public policy issue.

The science literacy gap has wider societal ramifications. The participation rate in elections produces a metric that mirrors that for performance in science education. In 2006, the proportion of voters in the Congressional elections comprised 54% of the adult population.[11] This is a low rate of participation by international standards, but the rate varied immensely by level of education. Only 31% of U.S. citizens with less than a high school education exercised their democratic franchise compared to 72% of those holding at least a college degree. One can conclude that the knowledge gap leads to low self-esteem, alienation, and a general disconnect from civic engagement. That this deficit correlates highly with racial and ethnic minority status is also socially significant. Thus the social gap produces and perpetuates an educational divide and produces a democratic deficit of serious dimensions. That Burkhardt's "Ralph the barber"[12] can remain happily ignorant of science is not just a failure of the Enlightenment project. Such ignorance can be expected to lead him to ignore and evade his responsibilities and duties as a citizen of a democratic republic.

Moreover, Ralph's children cannot long remain ignorant and still hope to maintain their present standard of living and quality of life. The requirements of the United States job markets have evolved over past generations. Recent analysis shows that the steepest decline in task input over the last decade has not been with manual tasks, as is often reported, but with routine cognitive tasks, i.e., those mental tasks that are well described by deductive or inductive rules, and that dominate many of today's middle-class jobs.[13] This suggests that if large numbers of American students learn merely to memorize and reproduce scientific knowledge and skills, they risk being prepared mainly for jobs that are disappearing from labor markets in most advanced industrialized countries.

Economic Performance

There is a cogent economic argument for securing strong baseline science competencies. For most of the 20th century, school science curricula, especially in the later stages of secondary education, tended to focus on providing the foundations for the professional training of a small number of scientists and engineers.[s] This continues to be the U.S. pattern for the top 10% of students. The curriculum mostly presented science in a form that focused on the knowledge of the science disciplines, while paying less attention to knowledge about science and applications relating to citizens' life and living. However, the influence of scientific and technological advances on today's economies, the central place of information technology in employment, and the increasing presence of science and technology-related issues require that all citizens, not just future scientists and engineers, have strong science competencies. The proportion of students at very low proficiency is therefore also an important indicator in terms of citizens' ability to participate fully in society, particularly as voters[15] and in the labor market. PISA and similar authorities have established five levels of science proficiency. Level 2 is regarded as the baseline, defining the level of achievement on the PISA science scale at which students begin to demonstrate the science competencies that will enable them to participate actively in real life situations related to science and technology. One-fourth of American students do not reach this level of proficiency. OECD reports that these students "often confuse key features of an investigation, apply incorrect scientific information, and mix personal beliefs with scientific facts in support of a decision."

The mismatch between the needs of the labor market (on one hand) and the educational skills of young people educated in the American educational system (on the other) is further evident from the following statistics. The proportion of science and engineering occupations in the United States that are filled by postgraduate-educated workers born abroad increased from 14% to 22% between 1990 and 2000, and from 24% to 38% when considering solely doctorate-level science and engineering workers.[16] Irrespective of arguments about the value of immigration to the nation, the reality of the labor markets is that such high-status, well-paid jobs are just not accessible to most young people educated in the U.S. and particularly not to women and U.S.-born minorities, who are particularly under-qualified in science.[17] Thus students graduating from today's American high schools are disadvantaged by their lack of educational preparation for careers in science and engineering.

Voters and Electoral Politics

There is also a non-economic argument for raising the level of science literacy for the mass of Americans whose level of science education does not place them in the elite 10%. As we shall demonstrate, the average voter is now asked about (and will increasingly be required to deliberate on) ballot questions and "political" arguments that involve a high level of scientific literacy: questions and issues such as nuclear energy, radiation, genetically modified (GM) crops, acid rain, greenhouse effects, as well as health and personal well-being issues: sunscreens, exercise, nutrition, and vaccination.

Given the frequency and civic importance of American elections, having an educated voting public is a matter of necessity in the United States. Americans go to the polls every year to decide a myriad of public offices for municipal, county, state, and federal governments—offices ranging from local commissioner of sanitation to the President. Moreover, Americans not only elect representatives and public officers but vote simultaneously in referenda and ballot initiatives. While most of the decisions can be (and in many ways are) made using ideological shortcuts such as political party partisanship, in the increasingly complex scientific and technological climate in which we live these days scientific developments require a nonpartisan decision-making approach.

In recent elections stem cell funding initiatives made it onto the ballots of two states: California (2004) and New Jersey (2007). In Missouri, in 2006, a similar quest led to a constitutional amendment ballot. Thus the general public cannot escape from engagement with science issues on the societal and personal levels. In fact, in an age of bio-medical advances, energy shortages and environmental crises due to climate change, the public and the voters will be increasingly called upon to evaluate scientific data and arguments. Of course, the lawyers, judges, and the courts will be even more closely involved. A signal example was the New Jersey 2007 ballot about floating a $450 million bond issue for a taxpayer-funded stem cell research program. As one might have predicted, even before the voters got a chance to decide, conservative groups tried unsuccessfully in the courts to derail the vote because they claimed the advisory statement accompanying the ballot was misleading on scientific grounds.[18] Of course, the advisory statement is what the voting public has to read if it wants to properly evaluate the proposal.

The partisan alignment in these state votes—especially in Missouri—is remarkable. In the case of Missouri's stem cell amendment, the election was extremely close (51-49%) in favor of the amendment. It was an election primarily decided by Missouri's independent voters. Republicans rejected the amendment by a margin of 76-24%, while Democrats voted in favor by the exact same margin.[19] Here we have a politically neutral decision, a vote on science policy, that became political fodder for party elites and groups at the extremes of the political debate.

A similar situation occurred in California in 2004, and again in 2006, though the voting was not as polarized, perhaps because the science and tax issues were somewhat muddled up. In 2004 a stem cell funding initiative was passed 59-41%. In this case the differences between Democrats and Republicans were not as marked; 64% of Republicans rejected the proposal while 80% of Democrats supported the measure. The California independents voted for the proposal 60-40%.[20] In a 2004 initiative regarding funding alternative fuels, California voters rejected the proposal 55-45%. The partisan splits were Democrats 65% in favor of the proposal, Republicans 71% against the proposal, and independents 52% against the proposal.[21]

These votes represent several problems regarding scientific literacy. First, they show extreme partisan splits in which Democrats overwhelmingly support ballot initiatives related to science policy and Republicans overwhelmingly reject them. Stuck in the middle are independents, who have both supported and rejected policies. These voting splits highlight a feature of recent politics whereby the Republicans emerge as an anti-science constituency. Much of this trend has to do with the conservative Christian constituency that is now part of the core of the Republican Party[22] and the linkage of religious conservatism to anti-scientific ideas.[23] This has alienated the Republican Party from the mainstream scientific discourse and led it to promote pseudo-sciences such as Intelligent Design Creationism,[24] global warming denialism, and the rejection of programs on embryonic stem cell research under pro-life activist pressure.[25]

Figure 10-1

State Ballot Initiatives and Referenda by Decade, 1904-2006

Period	Total	Average per election
1900-1909	23	7.7
1910-1919	274	27.4
1920-1929	189	21.0
1930-1939	257	28.6
1940-1949	159	19.9
1950-1959	127	18.1
1960-1969	98	14.0
1970-1979	177	17.7
1980-1989	247	24.7
1990-1999	379	37.9
2000-2006	301	43.0
Source: Initiative and Referendum Institute		

At the same time, we must hold the Democratic Party accountable as well. If Democratic voters are making science policy decisions based solely on partisanship, without regard for costs and feasibility, they are not really helping the cause of science. They are surrendering their rationality to party loyalty, even if it's a party that actually supports the science establishment nearly all the time. This is because, contrary to Burkhardt's opinion[26] the goal of science education is not to have the public "rubber stamp" the decisions scientists favor, but to have a rational public that understands, at a basic level, the costs and benefits of implementing such policies.

Another key fact is that whether we like it or not, ever more complicated decisions are falling into the hands of voters. The Initiative and Referendum Institute (IRI) at the University of Southern California, which tracks data on citizen initiatives, has found that since the 1990s, the voters have been deciding an increasing number of policies at the state level.[27] *Figure 10-1* shows the number of initiatives by decade, starting in 1904—when progressives started to gain ground in getting their reforms adopted—and ending in 2006.

The left-hand column shows the decade while the center column shows the total number of initiatives proposed in that decade. The right-hand column

Figure 10-2

Self-Reported Voter Turnout by Education Level, 2004, 2006

	2006		2004	
Education	**United States**	**Missouri**	**United States**	**California**
High School or Less	42%	48%	59%	57%
Some College	56%	62%	77%	74%
College Graduate	69%	75%	86%	82%
Post Graduate Degree	78%	88%	92%	89%
Total	54%	60%	72%	71%
Source: Current Population Survey, Data FERRETT				

represents the average number of proposals by year (only counting years within that decade that featured referenda or initiatives). During the heyday of the Progressive Era in the 1920s and 1930s, the average number of referenda peaked at 28.56/year during the period from 1930-1939. It never again rose over 20 initiatives per year until the period of 1980-1989. The 1990s represented the highest (raw) number of initiatives being presented to voters, and the current uncompleted decade is on pace to surpass the 1990s figure, already topping 300 and an average of 43 per election.

The IRI does not have a category of science policy questions in its database, although, browsing through the tables, it is clear that citizens have been asked about issues such as abortion, several policies concerning the environment and energy, and, of course, the biotech-related stem cell questions. Knowing more about science might help this decision-making process. It is irresponsible to think that because science is complicated, or scientific knowledge is not critical to the average person's daily survival, he or she can ignore the deepening educational void among the voting public. The anti-democratic alternative would be to remove the decision-making process from the people and leave it to technocrats (or elites). Regrettably, this is what is indirectly occurring since, as mentioned above, there is a real gap in participation in which the less-educated refrain from participating in elections and referenda in higher proportions than those with better education, as *Figure 10-2* clearly demonstrates. On average, around half of the least educated stay away from the polls while most of the most highly educated vote.

Figure 10-3 shows that the actual pattern of voting is less linear or polarized than turnout. However, there is a tendency for the best educated voters in

Figure 10-3

Vote by Education Level on Stem Cell Research Initiatives in California and Missouri[28]

	Missouri, 2006		California, 2004	
Education	**Yes**	**No**	**Yes**	**No**
High School or Less	53%	47%	55%	45%
Some College	48%	52%	60%	40%
College Graduate	50%	50%	59%	41%
Post Graduate Degree	57%	43%	65%	35%
Source: CNN				

California, the most populous state in the U.S., to be most supportive of science.

Polarization and extremism, even when one of those extremes tends to "agree" with the scientific mainstream or consensus, should not be the basis of policy decisions regarding science. Instead, we need an educated, rational public that can discern and critically determine which science policies to follow and which ones to dismiss. Considering that the recent explosion of citizen initiatives came after the end of the Cold War, this process seems to be one of "devolution" or returning to the people the power that was exercised during the Cold War by Eisenhower's famous "Military-Industrial Complex." Of course, this powerful "complex" was (and remains) very much a science and technology-based interest group, so in the interests of prudence and the common good it requires careful monitoring.

Elected Officials and Public Servants

We have focused so far on the need for the electorate to become more scientifically literate. However, we must also hold our elected leaders accountable. Polarization has not only occurred among voters. It might actually be more pronounced among elites. Several studies[29] have found that, ideologically speaking, party leaders and elected officials have moved to the extremes. Though we can track the beginning of this elite polarization to the 1970s,[30] this polarization has been exacerbated in recent decades.[31]

One reason ideology may have displaced reasoned discussion in this sphere is that there is a dearth of scientists and engineers elected to Congress. Whereas one-third of the members of the House in the 108th Congress were lawyers (JDs), only 18 members (or less than 1%) had a Ph.D.[32] And even then, not all the doctorates were in science. Given the increasing need for scientific regulation in the fields of telecommunications, public health, and biotechnology, for example, there is an obvious need for a body that can assist the current batch of elected officials in making sound judgments based on scientific evidence. Unfortunately, such a body once existed but is no more. The Office of Technology Assessment (OTA), a body that provided Congress with independent scientific analysis, was dismantled following the "Republican Revolution" of 1994.[33] In the case of the OTA, ideology (i.e., hostility to government, bureaucracy, and regulation) trumped reason and the common good.

Recommendations

Improvements in scientific literacy and science education appear critical to the future of democracy and the economy in the United States. One of the reasons is because "we the people" are being asked more often to make policy decisions that are intellectually beyond "our" reach and understanding. It can be argued that a scientifically illiterate electorate, today more than at any other juncture in American history, is seriously detrimental to the future survival of the nation. Yet, as has been shown, questions are being voted on by a largely uninformed and polarized electorate. In addition, a large segment of less educated Americans now exclude themselves from involvement in the democratic process.

One strategy for resolving this democratic deficit is to improve science education. The science establishment's new Committee on Prospering in the Global Economy of the 21st Century[34] proposes a project for "10,000 teachers, One Million minds." This is an initiative to get the brightest students interested in spreading science. The Committee also proposes "K-12 Curricular Materials Based on World-Class Standards." There are other recommendations in the same vein of strengthening science education, e.g., providing students with more laboratory experience,[35] and incentives for college and graduate education. Alas, these ideas somehow fail to address the issue of promoting "critical thinking" among students and focus on a rather narrow definition of what is educationally important.

Without getting into the specific institutional barriers—such as federalism—which militate against a standardized national science education curriculum in American schools, the problem is that this solution only addresses the needs of school-age children. In the meantime, and probably into the future, we need to make up for past deficiencies with remedial solutions that address the general public. In theory, the burgeoning media and new communication technologies offer an ideal vehicle for "remedial adult or informal education" in science. In reality, this probably requires massive public funding, which is very unlikely to be provided.

Another possibility is to increase citizen participation.[36] The problem is: what constitutes citizen participation? If it means merely throwing out questions for debate, we are failing. As the California and Missouri voting statistics by party identification clearly showed, even the half of the adult population that bothers to vote makes decisions based on party loyalties without necessarily thinking about them objectively. One possibility is a return to the ideals and practices of the past with attempts to revive the civic-minded and engaged society described by Alexis de Tocqueville in *Democracy in America*.[37] De Tocqueville was amazed at the levels of associational life existing in America in the 1830s and how they helped to promote democracy and progress—even at a time when franchise was limited to white men. Fast-forward about 200 years and we are faced with a decline of civic involvement in America.[38] This decline in civic involvement and real debate can be linked to the polarization of political discourse because those who are presently actively participating are those who tend to have more extreme opinions, and as such are less likely to compromise on most issues.[39]

Successful examples of methods to heighten public awareness of science-based public policy issues come from the United Kingdom, where a large section of the general public was educated about issues such as GM crops and the environment through focus groups and town meetings.[40] Of course, in the present U.S. political climate this type of activity would be labeled “advocacy” by opponents. This “informal public education” model has been adopted by former Vice-President and recent Nobel Prize laureate Al Gore, with his movie *An Inconvenient Truth,* his lecture tour and campaign to raise awareness about global warming, and his books such as *The Assault on Reason*.[41] Nevertheless, this approach can only reach a finite amount of people and seems to target college students and other well-educated members of the public. To become more widespread, it needs greater local mobilization. In this way it might improve the sense of efficacy among the public, especially among those who so far have been left out of the discussion and the political process altogether.

Another communication idea comes from Nisbet and Mooney[42] and their “Framing Science” approach, in which they exhort scientists to “learn to actively ‘frame’ information to make it relevant to different audiences.” Unfortunately, most of their article focuses on pandering to religious fundamentalists instead of really educating a less passionate and more disengaged core of the population.

Advocacy on behalf of rationalism and science has recently become more common. The Center for Inquiry, the publisher of the magazines *Free Inquiry* and *Skeptical Inquirer*, has recently expanded its operations on behalf of rationalism and in 2007 launched itself as a public policy lobbying group for science in Washington, D.C. In a similar fashion, a group of scientists and other interested parties have been pushing for a 2008 presidential science debate,[43] and a website (www.sciencedebate2008.com) has been created for that purpose.

Obviously, there is a growing concern about the need to address scientific (il)literacy among our elected officials. The country requires more politicians with a willingness and ability to engage with science-related issues, and with the ideas of science. One way to do this is to change the educational profile of elected officials and so reduce the number of lawyer-politicians. This requires more scientists to become active in public life and public debate and so provide greater critical analysis of scientific policies. We are seeing some signs of this tendency with the emergence of high-profile scientist-bloggers such as Greg Laden, PZ Myers, and Phil Plait, all of whom provide some political commentary in their blogs. A key immediate public policy need is the restoration by Congress of the Office of Technology Assessment. In fact, a restoration of OTA would be a great leap forward in alleviating the lack of scientific literacy among the members of Congress, and bloggers such as Mooney[44] and Myers[45] have promoted this idea in their blogs.

So what should be our intellectual and educational goals for the properly qualified, scientifically literate, 21st-century American voter and politician? Obviously the geometric growth in scientific knowledge and its increasing disciplinary differentiation poses a knowledge problem. Not even the most eminent scientist can keep up with the massive output of scientific knowledge in the contemporary world. What is feasibly required is a “meta-science” approach to science education, focusing on an immersion in scientific method and critical thinking. One aspiration should obviously be the ability to distinguish between evidence-based explanations and personal opinions about science-related issues. Another is an awareness of how science and technology shape our material, intellectual, and cultural environments. For example, Americans need an ability to recognize and explain the role of technologies as they influence the nation’s economy, social organization, and culture. This means that despite all the difficulties involved over the long haul, science education in U.S. schools needs to be recalibrated so that it both improves quality and assists equality of outcomes. The democratic imperative of American society requires a participatory citizenry that is confident in its ability to evaluate both its own best interests and the common good. To this end the scientific literacy that the “aware citizen” needs is an understanding that in science there are no absolute truths, no sacred cows, and no final secrets to be discovered that will allow all scientists in a field to retire and go home. Instead, our ideal citizen should know that all hypotheses and theories are subject to modification and even replacement as new research and discoveries become available. So students should emerge from school knowing that science is not dogmatic, and those who try to present it dogmatically are doing it a disservice. For as Millar says: "if one major purpose of science education is to equip students to respond to socio-scientific issues, this requires an understanding of the nature of scientific knowledge."[46]

One would also hope that the model American citizens of the future will be able to understand the definitions of commonly used terms. Perhaps most importantly they need to understand what "burden of proof" means. They are likely to meet this term in their civic role as a juror as it refers to legal matters, but they also need to know how it applies in other fields of human endeavor, like philosophy and science. Here we must remember that the average American is asked as a juror to make judgments in legal cases about DNA evidence and other scientific matters that are left to professional magistrates and judges in the law courts of most of Europe. Thus the average citizen needs to know that every affirmative statement carries a "burden of proof." Yet this burden does not imply proving something beyond a shadow of a doubt, but rather the responsibility to provide logical reasons for one's position. If one makes a public statement, then one has the burden of providing evidence for that statement. Furthermore, given the ever-more-demanding role of juror and voter, there may even be an argument for teaching basic philosophy and logic in 21st-century American high schools (as they do in France). That way, the populace would be able to recognize, for instance, that being skeptical is not the same as making affirmative statements that things are or are not. Americans would know that the essence of the skeptic is to question, not just to deny things.

The contemporary world situation—in which knowledge, particularly in scientific and technological fields, equals power—makes increasing intellectual demands on what many regard as a "dumbed-down" society. Unfortunately, the logic of history still seems to involve fierce global competition such that the average 21st-century American will not be able to flourish or perhaps even survive as a worker, juror, voter, or even consumer without a higher degree of science literacy. Those who are concerned with the future welfare of the nation should insist upon a higher degree of knowledge relevant to a technologically advanced civilization. This means getting more scientists out of the laboratory and into the world. There is a need for more men and women educated in science getting involved in journalism and communications, government and political parties, and grassroots organizations. Or as Mooney says: "we need more scientists with additional skills to boot."[47]

In the contemporary globalized world there is a premium on the integration of concepts and ideas. Science and technology can no longer be seen as isolated practices, but rather as activities that underpin every aspect of social and economic policy, and hence all aspects of government. This is known as "joined up" thinking. We would argue that we should extend this "thinking" to the nature of the linkage among secular values, science literacy and democracy. A major challenge for the 21st century is to raise the awareness of the American public and its leaders to this linkage.

ENDNOTES

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