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Where Values and Science Converge

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Teaching Controversial Science: Where Values and Science Converge

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Abstract: Scientific discovery and innovation are essential components of global progress and sustainability. However, current evidence suggests that science-based decision-making and outcomes are often challenged and countered by contrary views that rely on underlying beliefs and values rather than scientific assessment. Educators in scientific disciplines are at the forefront of many of these issues, frequently encountering them in their classrooms. Many initiatives aimed at addressing this challenge are designed to increase scientific literacy. While scientific and quantitative reasoning are important to attempt to address this disconnect, the role of personal values in decision-making must not be underestimated. This paper explores the role of college professors in supporting students as they analyze and negotiate controversial and often contentious topics in science, and discusses the role of students' values, beliefs, and perceptions on their of interpretation of scientific concepts.

Keywords: Education, Pedagogy, Controversial Issues in the Classroom

> "*In order to persuade members of the public to accept empirically sound information, it is necessary to do more than merely make such information available to them. It has less to do with differences in knowledge than differences in values*"
>
> *-D. Kahan*

INTRODUCTION: SCIENCE, POLICY, AND PUBLIC PERCEPTION

Scientific discovery and innovation are essential components of global progress and sustainability. In democratic societies, the role of scientific discoveries on informing and developing public policy is impacted by the public's understanding, views, and decisions regarding science. In such societies, the quality of decisions made by the public can have fundamental impacts on public policy. This is often articulated as a rationale for general, broad-based scientific literacy as a fundamental purpose of science education, which supports the long-term goal of developing students capable of making informed policy judgments with respect to science and society.

Despite several decades of initiatives and reforms focusing on scientific literacy, current culture is replete with examples of science-based decision-making and policy being co-opted by views that rely on underlying beliefs and values rather than valid scientific assessment. Examples include the belief that childhood vaccines are harmful, disbelief of evolution, and perceptions that scientists lack consensus on issues such as global climate change, genetically modified foods, stem cell research, and risks associated with nuclear power (National Science Foundation 2012; National Academy of Sciences 2012).

This phenomenon has received considerable attention, often labeled as "anti-science" or "denialism". Michael Specter defines "denialism" as when an entire segment of society, often struggling with the trauma of change, turns away from reality in favor of a more comfortable

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lie, and a "denialist" as someone who "unless data fits into an already formed theory, doesn't really see it as data at all" (Specter 2009, 3). While there is likely considerable debate over these specific definitions and labels, (in fact, the "anti-science" label is employed by people on all sides of a controversial issue in reference to the people holding the opposing viewpoint), the common theme is that people rely on "unscientific" modes of assessment in their analysis of controversial issues, and promote such assessments as equally-or more-valid than assessments based on scientific data. What concerns many scientists, educators, and policy makers is that such viewpoints have moved from the fringe to mainstream, giving them the potential to impact public policy and impede progress on critical scientific problems.

Science educators have a pivotal role in the development of students who can navigate this often-controversial nexus between science and society. Education seeks to instill in students a capacity for critical thinking. To be sure, many academic institutions hold the development of critical thinking skills in such high esteem that they include it in their mission statement and/or have centers and initiatives focused on critical thinking skills. In short, critical thinking (or lack thereof) is a major ongoing discussion within higher education.

In *The Sourcebook for Teaching Science*, Norman Herr describes critical thinkers as those who draw conclusions only after they have defined their terms, distinguished fact from opinion, asked relevant questions, made detailed observations, and uncovered assumptions. Critical thinkers make assertions based on solid evidence and sound logic (Herr 2008). In science, the shorthand we most often use to describe this is "scientific literacy."

Science Literacy, Public Opinion, and Decision Making: The Disconnect

Scientific literacy and critical thinking are antithetical to cultural trends in which scientific data and consensus are disregarded or marginalized during the formulation of decisions and opinions. But despite initiatives promoting science education and science literacy, public perceptions (science literacy) with regard to controversial socioscience issues do not appear to have increased significantly. The level of factual science knowledge has remained stable for the past ten years, with many Americans giving multiple incorrect answers about basic factual knowledge of science or the scientific process. Understanding of the scientific process has stabilized after modest improvements in the 1990s (National Science Foundation 2012).

With regard to some specific socioscience issues, opinions have not merely remained stable, but science has lost ground. For example, a recent report from the Pew Research Center for People and the Press found that in 2011 substantially fewer Americans believed there is solid evidence of global warming than did so from 2006 to 2008. Furthermore, between 2006 and 2008, a higher percentage of people viewed global warming as a very serious problem than do so today. Of note to educators, the level of education was not a strong predictor of peoples' views on this issue (Pew Research Center 2011). And while public acceptance of evolution is generally high among prosperous nations, the United States stands out as an outlier among wealthy nations where only one in three adults think that evolution is true (Ipsos 2012; Miller, Scott, and Okamoto 2006). A study using data from the National Immunization Survey for the period from 1995–2001 indicated that children who received no vaccines were more likely to belong to households with higher income and to have a married mother with a college education than were children who were partially (under)-vaccinated (Smith, Chu, and Barker 2004; Omer et al. 2009).

In a study of exploring college students' pre-existing believes about science, 234 undergraduate students were asked whether or not they thought that the precautionary principle should be applied to global warming[1]. Interestingly, compared to the students who supported applying the precautionary principle to global warming, a greater proportion of students *opposed* to

[1] The precautionary principle states that scientific uncertainty should not be a reason to postpone measures to prevent harm.

applying this principle used scientific reasoning in support of their position. However, in their application of the data, they used ideologies constructed from their pre-existing beliefs to interpret the data. For example, some students acknowledged the data demonstrating that temperature and sea levels are rising, but personally minimized the significance or consequences of these changes (Mari and Jofre 2012).

These observations suggest that education alone-or at least our current approaches to education-has not been adequate to deal with what some have called a cultural war on science. Dan Kahan of the Cultural Cognition Project asserts that if we wish to persuade members of the public to accept empirically sound scientific information, we will need to do more than merely make the information available to them (Kahan and Braman 2006). Science educators are at the forefront of providing students with the scientific foundation necessary to develop the critical thinking skills required to assess complex sociocultural issues. What do educators need to address in their own teaching approaches to ensure that they are doing more than "merely making information available" to students?

There have been many teaching and pedagogical initiatives over the past several decades. Most departments have reformed their curricula, moving from traditional content-driven, lecture-based instruction to interactive classrooms, inquiry-based or thematic learning, research rich curricula, etc. However, these reforms may not have adequately explored or addressed the role of underlying culture, beliefs and values on students' receptiveness to scientific ideas. Since "anti-science" decision-making relies on underlying beliefs and values rather than scientific assessment, understanding the role of these underlying systems of belief may enable teachers to more effectively link science literacy to critical thinking, particularly in regard to controversial socioscience issues.

College professors are well educated in their specific disciplines; they are very good at teaching scientific and quantitative reasoning skills, but often have less experience or expertise to support and assist students as they negotiate controversial and often contentious topics in science. In particular, most professors lack training in understanding how cultural components can bias the views of both students and instructors, and the role of personal values in decision-making. This is crucial if we want to assist and support students in their development of scientific literacy skills needed to assess scientific claims. By definition, controversial socioscientific issues often include disagreements related to the various participants' diverging evaluations of the scientific claims involved (Kolso 2001). To understand this, we need to understand how student pre-existing attitudes and perceptions shape their evaluation of the claims.

Beyond Scientific Literacy: It's More Complicated than Content, Concepts, and Process

Yale University's Cultural Cognition Project has demonstrated that individuals of diverse cultural outlooks hold sharply opposed beliefs about a range of issues including climate change and public health. They conclude that differences in cultural outlooks are more important in shaping perceptions than any other individual characteristic including gender, race, socioeconomic status, political ideology, party affiliation, or *education* (emphasis added) (Kahan et al. 2007).

Of particular interest to educators who often direct or lead classroom conversations, is the finding that the leading factor that most impacts how individuals respond to arguments about risks associated with vaccines or climate change is the perceived values of the person making the argument, not the validity of the argument itself (Kahan, Braman, and Jenkins-Smith 2010). This corresponds to what Michael Shermer calls "in-group" bias in which we place more value on the beliefs of those whom we perceive to be fellow members of our group, and less on those from different groups (Shermer 2011, 275). For example, in a study of how teenagers made their decision on whether or not to be vaccinated against pH1N1 influenza, school (and specifically science education) was seldom used in the decision. Instead, students relied on the perceived opinion of their peer group (Lundstrom, Ekborg, and Ideland 2011). This is not unexpected for teenagers, who rely heavily on peers in decision-making (of note, most first-year college students are teenagers, so this bias should not be trivialized). However, Kahan et al. demonstrated this "in-group" bias also exists in adults (Kahan et al. 2007).

The most critical observation informing how we deliver scientific concepts to students is the finding that perceived values of the person making the argument impacted people not only when they were processing information about familiar and already controversial issues (such as climate change or vaccines). Notably, cultural world views played a critical role in determining how individuals assessed new, unfamiliar risks (e.g. nanotechnology) as well (Kahan et al. 2008). Kahan et al. concluded that polarization around a particular issue interacts strongly with the relationship between the subject's cultural worldviews and the perceived worldviews of the expert advocating the position. Extrapolating this observation to the student/professor relationship suggests that when delivering novel content or ideas to students, student perception of the instructor's values may not only impact, but may well be the *most important* criterion in determining how students assess new information; even more important than their perceptions of the instructor's scientific expertise. If this holds even partially true, it may offer a clue to the inadequacy of science literacy initiatives to significantly improve public perceptions and assessment of socioscience issues.

How Can We Understand the Impact of Student Values on Navigating Controversial Issues in Science?

How can we neutralize the tendency of our students to polarize along cultural lines as they assimilate and process information? We first need to acknowledge these cultural divides exist and appreciate the role they play in student learning. Science education has embraced the social-science intersection for decades. In 1971, the National Science Teachers Association Committee on Curriculum articulated an explicit goal of deliberate integration of science education within its social function (Zeidler 1984). Dewey's notions of the democratic classroom permeate much of our pedagogy and classroom culture. However, many of us may have not considered how a student's perception of the instructor's biases or values may impact their acceptance (or rejection) of scientific content or concepts, even within structures designed to encourage student participation and engagement with controversial issues. According to the work of Kahan et al., these perceptions are likely to have critical impact on how our students engage, discuss, and interpret what occurs in the classroom.

How can we begin to recognize and confront our own biases in the classroom? It is a rare instructor who would claim that raising controversial socioscience issues in the classroom is a neutral activity. While most would likely acknowledge that students' pre-existing values will inform their responses to these issues, we may be less likely to understand or even perceive the impact of our own values on students' thinking and responses.

To make things even more complicated, instructors must first acknowledge their own values and biases. It is tempting to think that, as scientists, we are immune to such dynamics; that we have empirical truths that can penetrate the public debate (if only the public would just understand and become enlightened). This human tendency to recognize the cognitive biases in other people, but be blind to their influence on our own beliefs has been termed "the bias blind spot" (Shermer 2011, 276). If we want to pursue an honest exploration of the role of values in science teaching and literacy, it is critical to acknowledge that even scientists are not immune to these dynamics (MacCoun 1998). Like everyone else, we rely heavily on our prior experiences and values when evaluating the reliability of new information (MacCoun 1998). Even though we come to the classroom as professional teachers, we do not leave our social identities at the door.

Does this mean that we should try to remove all clues of our values and biases from our teaching? Probably not. Even if total elimination of values, or truly "neutral" teaching were possible, most likely, it would not be desirable.

A recent study of characteristics of excellent teachers found that students tend to relate *all* aspects of teaching to their interactions with professors and their perceptions of the professors' respect and caring for them (Pattison, Hale, and Gowens 2011). This study evaluating 1,932 responses from undergraduate and graduate students found that students perceived almost everything their professor did as a reflection of the professor's respect and caring for them (e.g. class administration, course preparation and delivery, teacher motivation, and student interactions) (Pattison, Hale, and Gowens 2011). In short, even behaviors that we think are devoid of values, such as class administration and content preparation, are interpreted as reflecting our attitudes toward them. Reminding us of the adage, "excellent teachers do not teach classes, they teach students."

An example from this study that is relative to engaging socioscience controversy in the classroom was the observation that students want to be challenged by teachers; faculty who excel at this were highly regarded by students. However, if students interpret the dialogue as threatening or abusive, they dismiss the instructor's feedback (along with dismissing the instructor altogether) (Pattison, Hale, and Gowens 2011).

So where does this leave us? In summary, the following observations may be useful in guiding our further exploration of this important teaching conundrum:

- Current culture presents many examples of science-based decision-making and policy being co-opted by views that rely on underlying beliefs and values rather than valid scientific assessment.
- Despite initiatives promoting science education and science literacy, public perceptions (science literacy) with regard to controversial socioscience issues do not appear to have increased significantly. This observation suggests that our current approaches to education have not been adequate for dealing with the problem.
- Evidence of a "science literacy disconnect" whereby even though they understand the science, students assess controversial issues through their pre-existing cultural lens, reinforces the notion that pre-existing values may trump science instruction.
- Differences in cultural outlooks are more important in shaping perceptions about many controversial socioscience issues than are gender, race, socioeconomic status, political ideology, party affiliation, or education.
- Student perception of the instructor's values may not only impact, but may be the most important criterion in determining how students assess course content and information; even more important than their perceptions of the instructor's scientific expertise.
- A central characteristic of excellent teachers is student perception that professors respect and care about them. Students tend to relate *all* aspects of teaching to their interactions with professors and their perceptions of the professors' respect and caring for them.

All of this appears to leave us in a "Catch-22." Student perceptions of our values are likely to have a significant impact on our ability to educate them regarding socioscience issues. Nevertheless, we can't be "valueless" instructors, not only because we are human, but also because the values of caring and respect impact our teaching and are perceived in everything that we do in the classroom.

While admittedly complex, these apparently conflicting goals do not need to be mutually exclusive, or impossible to achieve. Moving past our current cultural stalemate around socioscience issues will require wider acknowledgement of the role values, beliefs, and biases play in teaching and learning. Science professors must admit that we, too, are human and not immune to personal and cultural bias. More importantly, we need to continue well-designed studies that explore, quantify, and evaluate the role of student and professor values in effective teaching and learning. Results of these studies should inform ongoing conversations regarding curricular reform, effective pedagogy, and faculty development, with the long-term goal of developing students capable of making informed policy judgments with respect to science and society while improving public understanding, views, discourse, and decisions regarding science.

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