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Let's Talk About Values, Beliefs and Evidence

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In August 1945, the United States dropped the atomic bombs that devastated Hiroshima and Nagasaki. Seventy years later, the President Obama is imploring Congress to approve a deal to dissuade Iran from building a nuclear bomb. This is an opportune moment to reflect on the intersection of science, technology and human values. It is a time to ask how formal education can influence the next generation to make decisions that support rather than destroy humanity.

New scientific discoveries and new technologies are essential to address the world's most pressing problems. Strengthening K-12 science, technology, engineering and mathematics education can contribute to our nation's capacity, but only if education systems focus attention on one of the most essential learning activities– exploring how the interaction of values, beliefs and evidence influence public policy decisions that affect humanity. Unfortunately, our national obsession with easily measureable outcomes is distracting too many educators. Instead of consequential K-12 testing, we need consequential learning that prepares young people for life, work and citizenship.

In his 1956 book, Science and Human Values, Jacob Bronowski recalls his still vivid memory upon arriving in 1945 in a military Jeep as part of a British team visiting Japan to document the nuclear devastation in Nagasaki. He reports that a then current tune, *Is You or Is You Ain't My Baby*, was broadcasting from a nearby navy ship. He writes,

> Nothing happened in 1945 except that we changed the scale of our indifference to man…. The implications are both the industrial slum which Nagasaki was before it was bombed, and the ashy desolation which the bomb made of the slum. And Civilization asks of both ruins, Is You Or Is You Not My Baby?

That same year, Raymond L. Libby of American Cyanamid's research laboratories announced a method of orally administering the antibiotic penicillin.

Such is the awesome life and death power when the knowledge generated by the evidence-based enterprises of science, technology and engineering intersect with beliefs and human values. Today, there is no absence of controversial issues that demand consideration of that intersection, including global warming; the production, quality, safety and distribution of the world's supplies of food, water, and life saving drugs; and, the preservation of biodiversity–to name just a few. And, of course, slums are still ubiquitous in the US and around the world. We have yet to sufficiently harness the potential for technology in the service of such values-driven issues as ending poverty.

Bronowski's insight was brought to mind with the release of a Pew Research Center report, Americans, Politics and Science Issues. Analysis of the Pew survey results revealed,

> A larger share of the American public expresses issue positions that are either consistently liberal or conservative today than did so two decades ago, and there is more alignment between ideological orientation and party leanings.1 ….[For example], Democrats and liberals are more likely than Republicans and conservatives to say the Earth is warming, human activity is the cause of the change, the problem is serious and there is scientific consensus about the climate changes underway and the threat it poses to the planet….[However], other independent predictors of people's views include their religious affiliation, age, level of education, specific science knowledge and gender.

One particularly interesting finding is that:

> 60% of adults back the idea that public opinion should play an important role in policy decisions about scientific issues, while 35% say it should *not* "because these issues are too complex for the average person to understand. …. Those most likely to say public opinion should play an important role included conservatives, those without a college degree and several groups of religious believers. Those most likely to say public opinion should not play a role because the issues are too complex for the average person to understand included postgraduate degree holders, moderates and liberals, and those unaffiliated with religious groups.

An admittedly cynical interpretation of these findings is that conservatives and religious fundamentalists count on the public's scientific illiteracy to support their ideological preferences, while liberals and the highly educated are afraid that such ignorance will undermine their values-driven goals. The former is unconscionable, while the latter is contemptuous. Citizens without post-secondary degrees may justifiably feel that their voices and needs are often ignored by policy makers.

The Pew survey examined survey responders' scientific knowledge in six areas, but missed what is arguably the key issue. The science and engineering disciplines that have brought us both life-depriving and life-saving devices and processes are at their core evidence-based enterprises. However, the knowledge that is generated gets applied through the prism of values and beliefs. It is vital that the ways in which these contributors to decision-making influence one another are addressed explicitly in formal education, in the media and in political debate. Our failure to do so– either intentionally or to avoid conflict– undermines democracy, permitting power, demagoguery and prejudice to rule.

The National Research Council's Framework for K-12 Science Education was designed to provide educators with guidance for the next generation of science education. Several key features point to an opportunity for students to grapple with the how science, technology and engineering intersect with evidence-based decision making and human impact. First, it emphasizes that the technological products and processes that govern our lives are a human enterprise, guided by informed engineering designs that rest on an understanding of the natural world. Second, it asserts that this learning is for everyone, not just those already headed to related careers. Third, it places practices such as justifying claims and engineering-design decisions based on evidence at the center of learning. Fourth, it makes considering human impact a key feature of scientific literacy. For example, one core idea at the high school level is, "When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts."

Developing students' capacity to interpret information, and then to make, critique and revise claims based on evidence must be a primary goal of education. That implies a shift from the

current educational emphasis on students showing what they know on standardized tests to instead giving prominence to students demonstrating that they can find out what they need to know and use that information to solve problems. However, the capacity to assemble and interpret relevant information and the inclination and skill to generate evidence to defend and revise claims are not enough. Resolution of the trade-offs implicit in evaluating solutions turns not just on evidence, but also on often unexamined beliefs and values.

Non-evidentiary factors influence what information is collected and how data are interpreted. It is impossible to avoid the fact that values influence how and what students learn. School systems have a choice. They can either allow that influence to happen by default in unexplored darkness or in revealing light of explicit intent. For example, many students attend racially and socioeconomically segregated schools but never discuss that this is the result of policy choices, delivering an implicit message about what is normative and what our society values. When teachers avoid explicit discussion of contested decisions that affect humanity, students do not learn to grapple with the ways in which values influence whether and how evidence is considered. Alternatively, when high-school students learn about the production and heat capturing properties of green house gases such as carbon dioxide and methane, they have an opportunity to investigate the interaction of values and evidence in policies regarding the use of fossil fuels. Avoiding issues in which beliefs and values play a role leaves them ill prepared to participate debates about a major policy issue of our time.

It is time to be inquisitive in the classroom and explicit in education policy debates about how values and beliefs determine the ways in which evidence is interpreted and how that interaction influence important decisions that impact humanity. Yes, Dr. Bronowski, these decisions are indeed our babies.

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