Agnotology, Community Attitudes, and Student Critical-Thinking Skills

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Vexation

As science educators, most of us are familiar with the powerful urge to slap our foreheads—hard—when yet another survey reveals the poor state of the public's understanding of basic science (e.g. National Science Foundation, 2006, 2008). "Didn't they learn anything in my classes?" we cry, followed quickly by "I must be a worthless science teacher!" At least for some scientific issues, though, there might be another explanation for the public's (and our students') poor understanding: active attempts by misinformation campaigns to produce ignorance in the public mind, for purposes of achieving a political goal. Examples include efforts to teach intelligent design in public schools, and attempts to prevent legislation on carbon emissions, or bans on smoking in restaurants or bars. Distortions, misunderstandings and misinformation in each of these cases have turned issues that command a broad consensus in the scientific arena into issues that are highly contentious and vigorously debated in the public arena. These misinformation campaigns, and the negative effects they may be having on student learning, are the source of my vexation.

Yale science historian Robert Proctor has coined the term 'agnotology' to describe the study of culturally-produced ignorance (e.g. Proctor and Schiebinger, 2008). In contrast to the field of epistemology (the study of how and why we know things), agnotology is the study of how and why we *don't* know things. The reasons for ignorance of any specific issue can range from simple neglect, through cultural attitudes to gender or race, to military secrecy, to deliberate misinformation campaigns by groups with an interest in fostering doubt in the public mind. For example, efforts by the fossil-fuels lobby to portray the consensus on global warming as either environmentalist extremism or a media fabrication have been well documented (e.g. Gelbspan, 1998; see also the documentary *Everything's Cool*); and the tobacco industry even went so far as to proclaim (internally) that "Doubt is our product" (Proctor and Schiebinger, 2008).

Misinformation campaigns are often well funded, producing a stream of pronouncements on talk radio and in think tank-sponsored newspaper op-eds and blogs, as well as seemingly authoritative documents presented to look as if they are published in peer-reviewed scientific journals. These can be persuasive to the unwary or uninformed. Common tactics tend to exploit the public's lack of knowledge of the process of science, as well as lack of knowledge of the specifics of an issue. For example, the scientific community understands that a peer-reviewed journal is more reliable than a blog, website, or think tank-published report, but also that peer review is merely a necessary first step in the process. The general public, however, is not familiar with the intricate workings of peer review, so glossy, non-peer reviewed contrarian reports are often given equal credence, or widely refuted peer-reviewed articles from years ago are wheeled out to provide 'evidence' of the contrarian position. Commentaries in the news media (again, not peer-reviewed) often employ scientists from unrelated but impressive-sounding fields such as astrophysics or medicine, as if training in these fields somehow confers expertise on the fossil record of evolution, or the evidence for global warming. In general, misinformation campaigners typically portray themselves as a small group of tough-minded mavericks, taking on the 'junk science' of the 'establishment' (Jacques *et al*, 2008).

This presents science educators with a double-edged challenge. On the one hand, we must provide students with the scientific understanding and critical thinking skills they need to recognize misinformation when they see it; but on the other, students may have already made up their minds based on misinformation, and be predisposed to doubt what they hear in the classroom. If a student's broader (off-campus) community of family, friends, employers and colleagues is also more persuaded by misinformation than by the scientific consensus, our job as educators is made that much more difficult, because the broader community might have more credibility with students than their professors do.

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My venture seeks to address scientific argumentation skills for students within the Weber State University general education curriculum. University gen-ed mission statements support including this component, but I am unaware of any courses that actually do so explicitly. At present, I address scientific misinformation in only one course, an upper-division (non-gen ed) Weather and Climate course. Here students read and respond to Michael Crichton's novel *State of Fear* (Crichton, 2004), a readable and comprehensive collection of standard contrarian arguments about global warming, which is superficially persuasive but which collapses under closer (and better-informed) scrutiny. This exercise is a classic test of critical thinking—analyzing and dissecting an argument—and could/should be easily adapted to large introductory-level survey classes, where such exercises are arguably more important. A recent syndicated op-ed in the local newspaper (Murdock, 2008) may be ideal. Students could read and comment on the article early in the semester, before we cover any material on global warming; then later, when the material on global warming comes up, students could revisit what they had written and try to identify flaws in the op-ed's argument, possibly as an in-class discussion exercise. Clayton and Gautier (2006) have called for explicit consideration of processes of scientific argumentation (teaching students to distinguish style from substance), and dissecting a global warming op-ed article might be an interesting way of doing this.

Many other useful approaches surely exist, and a key part of my venture will be to try to recruit like-minded instructors to explore the possibilities and bring scientific argumentation into the WSU science gen-ed curriculum more widely. Scientific argumentation could be brought into multiple classes, dealing with different issues but employing the same basic skill set, and possibly a common text. The effectiveness of classes that incorporate this component could be tested by comparison with classes that don't. It would be helpful if my fellow workshop participants could point me towards any existing research in this area, or towards any existing survey instruments that might help chart either the effectiveness of instruction in scientific argumentation, or any changes in student attitudes that result (or both). Suggestions for a suitable common text would also be welcome.

A final unresolved question concerns the role of the wider community in affecting student learning of some of these artificially contentious issues. In northern Utah, this wider community is deeply sceptical about the scientific consensuses on global warming and evolution, for example. Limited public opinion data support this observation (Fahys, 2006), and anecdotally, many students have told me that they have family members (usually one or both parents) who adamantly denounce the scientific consensus on global warming. I am very curious to know if there is an existing body of research regarding the influence of this broader community on student attitudes to such issues—and if there is, what has it uncovered?