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FACT • OR • FAUX

Undermining Science: Doubt and Deception

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ABSTRACT

The Fact-or-Faux series addresses misinformation and science media literacy. Here, we consider the tactics used by industry and others to foster doubt in and undermine the scientific consensus.

Keywords: Consensus; uncertainty; skepticism; disinformation playbook

Many of the "truths" produced by science are "inconvenient" for some industries. Think of the problems that scientific evidence for climate change poses for Big Oil or the health risks of smoking for Big Tobacco. Such industries naturally want to undermine the science. Time and time again, research shows that the best way to do this is to create doubt about the science, even when there is a well-established scientific consensus (Michaels 2020; Oreskes and Conway 2010).

The most famous case is the 40-year struggle by the tobacco industry to undermine the conclusion that smoking was dangerous. Realizing that they could not win the scientific argument, a public relations firm developed the alternative—doubt. This was well described in a 1969 internal memo:

> Doubt is our product since it is the best way of competing with the "body of fact" that exists in the mind of the public. It is also the means of establishing a controversy. (Michaels, 2008, p. x)

Generating doubt has now become the foundation of the playbook used by any industry for whom the truths science offers are at odds with their

business goals. The same playbook has been used to cast doubt on the scientific evidence that climate change is (1) happening and (2) caused by human activity. Less well known are its use against the evidence that opioids are addictive or that there may be adverse effects from glycophosphates, alcohol, diesel fumes, and even vaccines. Why is this strategy so effective? What are their methods? And, most important, what should or what can science teachers do to alert students to these nefarious tactics?

The challenge for students (and adults) is that the science they are often most familiar with—school science—deals in knowledge that is unequivocal, uncontested, and unquestioned. That, after all, is why that science is in the textbook. Such knowledge is so foundational to the sciences that it is beyond questioning. There's nothing wrong with this. We want students to be introduced to the best that is worth knowing—knowledge that has been shown to be trustworthy and reliable. However, it's a problem if we want to prepare students to be "critical consumers of scientific information" (National Research Council 2012, p. 41). Why? Because from their school experience, students come to expect scientific knowledge to be indisputable. When they encounter science that is "in-the-making" or when an industry argues that the information is incomplete and open to debate, they will often err on the side of doubt. After all, why act if the science might be wrong?

What can the teacher of science do? Educating students for a world where science informs so many daily issues requires that students be taught some of the foundational ideas of science. But they also need to know about both the social practices of science that enable the production of reliable knowledge and the tactics used outside of science by the media and others to contest that knowledge by those for whom it is an "inconvenient truth."

Disseminating doubt

Casting doubt about the science has a simple strategy. Its foundation is that government institutions cannot act without justification. They must appeal to the settled science. What better way to frustrate regulatory action than to erode confidence in the idea that the science is settled? Any industry with a vested interest in its harmful product can then continue to sell it, or its workers may continue to work in unsafe environments. How do these industries do this so effectively? There are three basic approaches.

Gambit 1: Pay for scientists to do questionable research

One well-known example of this is the pain-killing drug Vioxx (now no longer available). As required by the Food and Drug Administration, the drug company Merck set up a randomized trial with 8,000 patients to compare Vioxx to another similar drug (Aleve). The early results were inconclusive. Merck scientists argued, however, that these results merely showed how good a drug Aleve was, not that taking Vioxx was risky.

Only when Vioxx was tested against a placebo in a new trial to see whether it was effective against polyps in the colon did the correct interpretation come to light. People taking Vioxx were twice as likely to suffer a cardiovascular event. In short, Vioxx can cause heart attacks. The Food and Drug Administration estimated that, in the 4 years Vioxx was on the market, it caused 88,000 to 139,000 heart attacks/strokes, 30% to 40% of which were fatal. Put simply, bad science kills.

What this example shows is that the results of any research are open to interpretation. Picking an interpretation that favors the industry is one way of sowing the seeds of doubt. It is most common in drug trials when the stakes are high. Look, for instance, at the enormous sales (and profits) being made currently from obesity drugs.

Gambit 2: Pay for a new literature review—and be selective with the literature and the statistics

This tactic starts from the premise that knowledge is science is the product of not a single study but many studies over time. If the question is important enough, these studies will have been conducted. If so, then a review of the literature is a standard technique for establishing whether there is a consensus on any question. For instance, is inquiry-based teaching a good or bad idea? The evidence would suggest that it is (de Jong et al. 2023; Furtak and Kunter 2012), but that does not stop it being contested (Zhang and Cobern 2021). With environmental or health issues, there may not be a simple answer to questions like, "Does this chemical cause cancer?" or "Is drinking alcohol bad for your health?" Rather, the important and much more difficult question is answering the question, "Is there a safe level of exposure below which the chemical/food/drink will have no effect?" Given the vast sums of money involved, it is no surprise to learn that a bevy of "product defense firms" have emerged. For example, Gradient, ENVIRON, and Hill & Knowlton will happily conduct a review of the literature and provide the conclusions you want—basically that there is insufficient evidence to warrant legislation (Michaels 2020). Indeed, there are so many firms engaged in this activity that it is more aptly described as an industry. Yet one more way to sow the seeds of doubt.

But how can such a study be published, you might ask, if it is peer-reviewed? Easily. First there is a burgeoning plethora of journals—many of which have lax mechanisms of peer review. Second, if the work is superficially sound, it would pass peer review, especially if the author had omitted the fact that there was a conflict of interest because they were being funded by the very industry in question—a basic red flag that the methods might be suspicious. And, with complex questions where the science is uncertain, there will always be studies that support higher limits of exposure.

Gambit 3: Set up an official body that appears to be independent

Just as gambits 1 and 2 acknowledge that the science matters, so does this one. Here it builds on the familiar notion that the authority of science comes from the many independent institutions that represent scientists and the consensus of experts (Zucker and Miller 2024). There is, for instance, the National Academies of Sciences, the Centers for Disease Control and Prevention, the Royal Society, and more. What better way to deceive the public than to establish a seemingly independent body with a governing

STUDENT INQUIRY ACTIVITY: Developing Students' Critical Competency

Invite students to investigate in small groups one of the following organizations. Give them a mix from the right and left column (those on the right are somewhat less suspect).

Responsible Science Policy Coalition	American Clean Power Association
The American Pain Foundation	North American Meat Institute
The Silica Coalition	American Iron and Steel Institute
The European Research Group on Environment and Health in the Transport Sector	American Academy of Pediatrics
The Sugar Research Foundation/Sugar Association	Aerospace Industries Association
The Global Energy Balance Network	International Council on Mining and Metals
The American College of Pediatricians	Energy and Minerals Business Council

Ask students to see whether they can find 2 sources that confirm their view about the credibility of the organization. If there is time, ask them whether they can find an organization that is more deserving of their trust and why.

After 10 minutes ask students to report to the rest of the class what they have found—in particular, whether they would trust any science they promote.

Following are two sample reports. Making it a competition to see who can come up the best arguments for any one organization adds a motivational element.

> American Council on Science and Health. https://www.acsh.org/. This organization advocates against "regulation of chemicals without scientific proof of harm." This is the opposite of the precautionary principle of "first, do no harm." It advocates against the regulation of bisphenol-A, phthalates, flame retardants, and the herbicide atrazine. It has also advocated against the taxation of foods known to contribute to weight gain—all somewhat surprising given the strapline on its web page is "Promoting Science and Debunking Junk since 1978." Not surprisingly, it has been shown to have been funded or still funded by Chevron, Coca-Cola, Bristol-Myers Squibb, Dr Pepper Snapple Group, Bayer Crop Science, Procter & Gamble, Syngenta, 3M, and McDonald's.
>
> Alcohol Beverage Medical Research Foundation. https://www.abmrf.org/. The avowed aim of this group is to "fund research and conferences to better understand the effects of alcohol on health and behavior." The Foundation is known to be funded by American and Canadian brewing companies—something that is not acknowledged on its website. Critiques have pointed to the fact that this organization "attempts specifically to fund research on 'industry-favorable' topics such as the health benefits of moderate drinking" (Babor 2009, p. 37). Researchers who receive funding from this organization are known to be substantially more likely to reach positive results about the effects of alcohol on human health.

More good science examples can be found at https://cor.inquirygroup.org/curriculum/collections/cor-for-the-science-classroom.

council, a website, and "official reports" that challenge the inconvenient science emerging in the field. This is a technique that has been used again and again by "Big Tobacco," "Big Oil," "Big Booze," "Big Pharma," and "Big Sugar." What is going on here is that the public's high trust in the "authoritative voice" of science (3M Corporation 2022) and scientific institutions is being leveraged to undermine the truths that these groups find so inconvenient (National Academies of Sciences, Engineering, and Medicine 2024). Yet one more way to sow doubt.

Educating the future citizen

The challenge for science teachers is that school science is exclusively a landscape of settled science. Why else would it be in the textbook? Inevitably this imbues a view of the certainty that is unrealistic when it comes to any new findings that might inform public policy. Students who emerge believing that science is certain (as I did) are then easy prey for those who wish to plant the seeds of doubt. "Why should this science be acted on when it is surrounded by doubt? Surely, we must be absolutely sure before we act?" What, then, can the science teacher do to enlighten their students to these abuses and those who wish to deceive with a tangled web of lies?

Knowledge is a social product

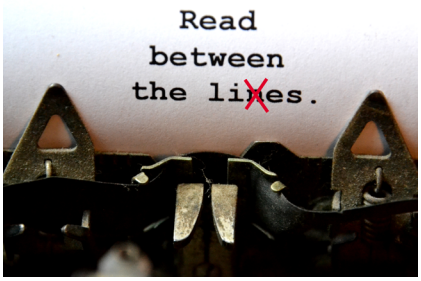
One of the misconceptions perpetrated by school science is the myth of the lone scientist. Overwhelmingly, K–12 science portrays all significant ideas or discoveries as the product of one heroic individual working alone—Darwin exploring the Galapagos Islands, Einstein at his patent desk, Newton under his apple tree, Curie in her laboratory. Nothing could be further from the truth. Scientific knowledge is produced by a community of scientists who challenge each other's new ideas. All these ideas were only possible because of the work of others that came before them. Yes, they had great insights, but those insights would not have been possible on their own. And their ideas were only accepted because they survived the vetting of the scientific community. Emerging from this process was a consensus that their claims were true. And it is consensus that is the ultimate goal of science (Ziman 1968).

Thus, giving equal weight to both sides of a scientific debate (a common journalistic norm) is not appropriate when the scientific evidence overwhelmingly points in one direction. This is the equivalent of giving equal weight to a flat Earther and the director of NASA. Inevitably it promotes doubt where none should be. The underhanded nature of this technique can only be understood if students have some understanding of the significance of consensus among the scientific community and how it is attained.

Moreover, all the eight practices found in the *NGSS (Next Generation Science Standards)* are not something engaged in by lone individuals. Rather, they are the practices of a scientific community that seeks to mitigate and eliminate error. Talking about how this is achieved is an essential element of illuminating what it means to do science.

Check out the source

To think that science will not be questioned by those with political and vested



interests is naïve. But who is doing the questioning? Do they have a conflict of interest? Do they have relevant expertise? Answering these questions means teaching students not to evaluate the science but rather the source reporting the science. They do not have the expertise to evaluate the health risks of ultra-processed foods, the effects of diesel fumes on health, or the safety of vaccines. Rather, they must start by asking whether the source can be trusted (Sperber et al. 2010).

Open a new tab, consult Wikipedia, Snopes.com, or other sources to see whether a source has the relevant expertise or a conflict of interest or, alternatively, lacks the relevant expertise. Is this "authoritative" institution or body really one that represents the expert community (see Pimentel 2025; Wineburg 2024). The goal of all three gambits above is to persuade the non-expert that the experts cannot be trusted. But, if so, why have they failed to convince the experts themselves? It's akin to arguing that the pilot of the plane we are on cannot be trusted to fly it even though they have been through a rigorous training and that we know better than them and can fly it ourselves.

Last words

Fundamentally, students need an education that will help them make informed decisions. Sadly, it is not enough to know just how scientists produce reliable knowledge. Students also

need to become savvy consumers of scientific claims—people who can distinguish fact from faux in the media. Doing that requires knowing the tactics that many an industry uses to undermine the work of scientific experts. It is only the science teacher who can forewarn the students. Only then will our students be forearmed.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author.

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