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The Internet and the Truth about Science: We Gave a Science War But Nobody Came

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Abstract
Even though sophisticated discussion of the nature of scientific claims is taking place in the academy, public school teachers of science and mathematics may harbor naive assumptions about the way that scientific processes function to construct the "truth." Reluctant to change their prior assumptions about science, such teachers may become vulnerable to information technologies (including "low-tech" media such as textbooks and films) that construe science as a collection of facts. An on-line lesson about constructivism provided a forum in which a group of teachers revealed well-established epistemologies seemingly inimical to the principles of conceptual change teaching. Further, the strategies used by the teachers to quell a potentially interesting debate provided preliminary evidence of differences in the motives for communication in virtual, in contrast to real, communities.

> "The teaching of mathematics and science is often authoritarian; and this is antithetical not only to the principles of radical/democratic pedagogy but to the principles of science itself. No wonder most Americans can't distinguish between science and pseudoscience: their science teachers have never given them any rational grounds for doing so. . . . Is it then any surprise that 36% of Americans believe in telepathy . . . ?" (Sokal, 1996)

Introduction

Those of us who are interested in science and science education are familiar with controversies involving science and the role of science in society. Recent decades have seen concern over the link between science and the military, threats to the environment posed by new technology, and the implications of advances in biotechnology. Conflicts between science and organized religion, such as the ongoing battles around the topic of evolution, also occur (Gould, 1980; Montagu, 1984; Nelkin, 1982) Whereas the issues raised by these conflicts are important, they do not strike at the foundations of science. Rather, while assuming--sometimes in a naive way--the epistemological claims of science, they question its uses and applications.

Fundamentally different, though, is the battle currently taking place, described by some as the "science wars" (McMillen, 1996). This debate does not focus primarily on the ways that science will be used or on how science threatens certain theological beliefs. Fundamentally more radical, this discussion questions the foundational claim of science, that science can provide an objective view of the physical world.

Advanced by scholars in the social sciences and humanities who study and describe the cultural, social, and political influences on science, this discussion often calls upon arguments from postmodernist philosophy. These arguments concern our ability as human beings to separate knowledge of the world from our personal and social constructions of it. Postmodernists suggest that we each play an important role in constructing our own reality. Given the importance of different social and cultural influences--language being the foremost example--our individual realities cannot be expected to coincide. On this view, scientists have always been and continue to be as vulnerable as the rest of us to the influences of personal experience, culture, and language. Whereas scientific interpretations of the world may be more systematic than non- scientific interpretations, they are not necessarily more true. This argument, of course, challenges the privileged role of science as the sole interpreter of the "real world" (Anderson, 1990).

The recent "Sokal controversy" provided dramatic evidence of the degree to which the "science wars" are now escalating. Physicist Alan Sokal submitted an article questioning the objective basis of science to the journal, *Social Text*, an important postmodern journal (Berkowitz, 1996). His article expressed many of the ideas and views held by postmodernists and carried the additional cachet of being written by a scientist. Shortly after the article was published, Sokal published a second article revealing the first as a hoax. According to Sokal, his aim in perpetrating the hoax was to challenge the academic standards of those scholars who endorse and contribute to postmodern theory. In his view, the editorial board's decision to publish his first article was proof of the slipshod standards and gullibility of scholars in the postmodern camp.

Because this controversy has widened, now encompassing a number of academics from different disciplines and universities (McMillen, 1996), we wondered what meaning it might hold for the classroom science teacher. Academics are raising and debating fundamental questions about the nature and status of science. Should public school science teachers remain unaware of the issues being raised? Should they remain distant from these important discussions?

Recently we had the opportunity to introduce at least some aspects of the discussion to a group of science and mathematics teachers. Whereas we did not plan to discuss the "science wars" per se or to review the Sokal controversy, we did hope to engender discussion of some of the underlying questions: "How do we, as individuals,

come to judge what is or is not science?" "What are the boundaries that we establish for our personal beliefs?" "Do these boundaries coincide with those set by science?" It was our intention, through the medium of an on-line course--part of a project with which we were involved--to ask teachers these questions, evoking discussion of foundational issues and relating these issues to the practice of teaching science.

Background

The on-line course was part of the West Virginia K-12 Ruralnet project, an NSF funded initiative whose primary work was to train and assist West Virginia science and mathematics teachers to use the Internet in a variety of ways that enhance classroom instruction.1 Over the forty-two months of its duration, the project worked with approximately 1000 teachers from throughout the state and from every grade level.

In its initial phase, the project provided a two-week summer training session to a group of approximately 40 teachers who were selected to serve as teacher-leaders over the course of the project. These teacher-leaders also participated in two on-line courses, for graduate credit, offered through the two universities involved in the project. Whereas the fall on-line course focused on the practice and development of Internet skills, such as the use of e-mail, listservs, and gopher, the spring course concentrated on the use of Internet resources in the classroom.

Following guidelines set forth in West Virginia's new Science Curriculum Framework, the Ruralnet project advocated a constructivist approach to science teaching. Constructivism not only provides a philosophical framework for the teaching of science, but, as we will discuss below, offers special lessons for the use of the Internet in the classroom. It is this notion of constructivism that lies at the heart of the "science wars" as well. Constructivism raises questions about how our own experiences, ideas, and concepts affect what we come to know through science. It challenges conventions of science instruction that represent science as an absolute and objective picture of the world.

Guided by this approach, we decided that the initial lesson for the course would involve the teacher-leaders in an exercise that implemented constructivist philosophy through conceptual change teaching. Simply stated, conceptual change teaching suggests that learning situations involve the following steps: (1) allowing the learner to state his or her initial concept of a particular phenomenon, (2) engaging in evidence gathering and discourse, debating the merits of different concepts, and (3) restating more adequate concepts (Posner, Strike, Hewson, Gertzog, 1982) This, of course, is an iterative process, continuing as long as time permits. Learners continue to develop their concepts through the process of examination and discourse.

We adopted these steps as the basis for the lesson. We would first provide the teacher-leaders with a topic and ask them to post their initial concept of that topic. The next few weeks would consist of gathering evidence, posting that evidence, engaging in online discourse, and restating concepts. The teacher-leaders would post a final conception and then address several questions regarding how and why they experienced conceptual change.

A good deal of consideration was given to the topic we would discuss. As different phenomena were suggested, we noticed that several criteria were emerging:

- The topic should engender discussion about the nature of science, the scientific method, or what constitutes scientific evidence.
- The topic should not be one where a few experts might dominate the discussion by providing the one "right" answer or explanation.

- The topic should be one about which all teacher-leaders might feel confident in offering opinions.
- The topic should be one to which all teacher-leaders should have had some exposure: we should avoid esoteric, little-known areas of knowledge.
- The topic should be somewhat controversial, but not one in which individuals might place a high degree of value; for example, the topic of creationism might threaten religious beliefs.
- The topic should not be one for which the teacher-leaders would be able to go to a book to find out what they think they should know.
- There should be a good deal of information concerning the topic available on the Internet.
- And perhaps most important, this topic should be compelling enough to engage people in on-line conversation.

The topic we chose was psychic phenomena (i.e., fortune telling, ghosts, channeling, and so on). In addition to meeting our criteria, this topic also was timely: news had just come out concerning the expenditure of millions of dollars by the Defense Department for psychic investigations; a recent broadcast of NOVA, the science-oriented television show, had discussed the evidence for various psychic phenomena; and commercials advertising psychic "readings" were becoming fairly common on television and radio.

We also suspected that the teacher-leaders might have some personal anecdotes or feel comfortable in sharing some "friend-of-a-friend" stories in regard to this topic. Whereas the topic is controversial, we felt that it would not be threatening. We did not believe that it would be linked to value issues, such as religion or politics. It also seemed to be a fairly easy topic to discuss, not requiring technical knowledge or a specialized vocabulary. We suspected that there would be few, if any, authorities on the topic among the teacher-leaders. Additionally, there is a great deal of information available on the Internet in regard to this topic (Sheaffer, 1996). There are numerous sites for skeptics and believers, as well as for the just plain curious.

Furthermore, the topic certainly applies to science, perhaps even challenging conventional wisdom about what might constitute scientific method, reasoning, and evidence. Many of the Internet sites dealing with this topic provide data, discuss research, and "look" scientific (e.g., Princeton Engineering Anomalies Research, on-line), yet the majority of scientists are skeptical of many of the claims made by these investigators (Schick & Vaughn, 1995.) In fact, the scientific appearance of some questionable sites raises a critical issue we had not considered in our initial thoughts on bringing the "science wars" to classroom teachers. If the written word carries power, what kind of power is carried by the animated-graphical-hypertexted-morphed-video-clipped word? The World Wide Web provides a very large audience to just about anyone who can put up an attractive web page. As teachers browse pages (or use search engines to locate sites related to various science topics) how will they be able to judge what is "good" science as opposed to what is "bad" science?

In summary, we felt that the subject of psychic phenomena met our criteria very well. It would provide a good test case for the application of constructivism (and conceptual change teaching) to the use of the Internet in the classroom. Learners would not be given meaning; they would construct meaning through a process of social negotiation. This is where the true value of the Internet in this experiment became obvious. How else could we engage over 40 teachers, from different grade levels and

from throughout the state, in social negotiation? What other environment offered such a forum? The participants had common access to a vast amount of information and the ability to communicate almost instantaneously with a relatively large number of peers.

The exercise would also provide the teachers with a framework from which they might view the "science wars." Without some experiential grounding, the claims of the postmodernists seem to be without merit and would most likely be dismissed without consideration. Teachers armed with the experience of seeing how their own constructions are determined and changed would be more likely to gain from theoretical exchanges about the nature of science and its epistemological claims.

Response to the Lesson

We started the lesson with a discussion of its aims, acknowledging explicitly that the topic--psychic abilities--provided a case in point. We indicated in our opening messages that the activities involved in the lesson had more to do with constructivism than with psychic abilities per se. We asked the teachers to suspend their disbelief and to view the lesson as a simulation of conceptual change teaching.

Despite what we thought to be a forthright yet inviting introduction to the lesson, the teachers were not especially receptive. They were neither interested in its constructivist focus nor accepting of its incorporation of psychic abilities as the example of a controversial topic. Several teachers claimed that the lesson was a "joke" or a "waste of time", and a number of them found the topics (both the topic of psychic abilities and the topic of constructivism) "irrelevant", "lacking in interest", and "useless" for them as teachers. This disposition, shared among many of the discussants, may have been responsible for their reluctance to engage with the lesson in the playful, yet serious, manner that we had hoped they would embrace. Despite their reluctance, the teachers did undertake a rudimentary discussion of the topic, which revealed their general stance toward psychic abilities, their strategies of argument, and a surprising but important recontextualization of the issues at stake.

Analysis of the e-mail exchange revealed that, in general, the teachers expressed one of three possible stances toward psychic abilities. Some teachers adopted a stance of uncritical rejection. One teacher's characterization exemplifies this approach: "there is no such thing as psychic ability ... I believe my statement to be undeniable". Another stance embodied uncritical acceptance, characterized by statements such as the following: "although rare ... psychic abilities do exist in certain individuals". Despite the fact that these two stances represent contrasting opinions, neither is critical because neither depends upon nor calls for warrant of any type. Both approaches tend to conflate opinion with true belief, and most of the teachers seemed willing to treat unsupported opinion as sufficient warrant in and of itself. A third approach invoked open-mindedness in dealing with the question of psychic abilities. Some of the teachers who took this approach did so because they did not have a definitive position about the topic-- they spoke of "not closing doors". Others seemed to adopt it because they subscribed definitively to a "scientific" way of thinking, construing science as a method that "always allows for the possibility" of new discoveries. Under this latter construction, the very process of science would require the teachers to take a skeptical rather than a dogmatic stance toward the question.

After making their initial claims about psychic abilities, the teachers provided arguments to elaborate their positions. These arguments tended to be naive, in that they almost always belittled the possible merits of opposing positions. For example, one teacher argued, "I cannot in all seriousness, believe that 'my personal psychic' can tell me

what lies ahead for $2.50 for the first minute...." By equating all psychics with "my personal psychic", this teacher challenged the seriousness of any claim that psychic abilities might really exist.

Most of the arguments provided by the teachers subscribed to this general perspective, though there were some interesting variations. A number of teachers chose to "explain away" psychic abilities rather than to give reasons for believing that such abilities are not real. According to one teacher, "a large quantity of so-called 'psychic experiences' are schemes to make money." Others called them "delusions","coincidences", "good guessing," "scams", "hunches", and "our own subconscious controlling our minds". These characterizations, which constituted the most prevalent claims made over the course of the entire discussion, served to distance the teachers from the topic, keeping them somehow immune from it. This strategy was surprising in light of the fact that a few participants did engage the question earnestly and offered some compelling arguments on both sides of the issue. Teachers who distanced themselves from the earnest thread of the discussion tended to marginalize the efforts of those who remained engaged.

One of the arguments, offered by two or three of the teachers who took the discussion seriously, attempted to account for the possibility that psychic abilities might exist. These teachers argued that intuition was part of everyday experience and that psychic abilities might, therefore, involve extraordinary intuitive talent. They also made the claim that the brain had "uncharted reaches" that might house abilities as yet undisclosed.

The most sophisticated arguments offered in the discussion took an inquiring stance and tended to invoke the scientific method as a truth test for the claims made by psychics or by those who believe that psychic abilities exist. Teachers who argued from this vantage seemed to maintain that the burden of scientific proof fell to those making claims about powers that were not within everyone's experience. According to one teacher, "extraordinary claims of any sort require extraordinary proof." Another teacher called for controlled experiments with replicable findings. And another suggested that the scientific community had already reached consensus on the question. Though different, these arguments all spoke to the requirement that such questions be approached both publicly and systematically.

A less sophisticated, but still serious, form of argument relied on personal warrant. This approach was used by teachers arguing on both sides of the question. Several female teachers spoke of "mothers' intuition" as an almost-psychic experience. Others recounted experiences of clairvoyance that could not be explained in conventional terms. And a few teachers used the fact that they had never had psychic experiences or seen demonstrations of psychic abilities as evidence that such experiences and abilities do not exist.

A final class of arguments relied on a fallacy known as "the fallacy of accident". In this case, teachers argued from the general to the particular without attending to the specifics of the particular circumstances. For example, one teacher claimed that if psychic abilities exist then "I do not think some tragedies like the Oklahoma bombing or the Challenger explosion would occur". This reasoning suggests that the existence of tragedies renders impossible the existence of psychic abilities that might predict such tragedies. It doesn't take into account the variety of possible conditions that could mediate the direct connection between any prediction and the actual event or the circumstances that might keep any such prediction from being made, on the one hand, or becoming public knowledge, on the other.

Rather than arguing about the existence of psychic abilities, a few teachers sought

to reframe the question in ways that we never anticipated. These teachers contextualized the question within the spiritual rather than the empirical domain and then used Biblical text to warrant their views about it. One teacher wrote: "I do not have any scientific evidence for the existence or non-existence of psychic abilities. However, as a Christian and a believer in the biblical records presented in the Bible, I would have to believe in the existence of psychic abilities." Another teacher, accepting the Biblical claims for the existence of such abilities, cited Leviticus 18:10-12 as a caution against the use of such abilities: "Let no one be found among you ... who practices divination or sorcery ... or who is a medium or spirit or who consults the dead. Anyone who does these things is detestable to the Lord...." As with some of the other argumentative strategies used, this recontextualization of the question assumed a stance that was so definitive that it served to protect teachers from the discussion rather than involving them in it.

This stance, as it was articulated in response to the original version of the question as well as to the recontextualized version, managed to render as unarguable a topic that the lesson identified as prototypically arguable. It clearly transformed the nature of a dialogue that was supposed to constitute and exemplify "constructivist" teaching and learning. It is not clear to us whether or not this transformation was intended by the teachers as a way to defeat the premises of the lesson. But it does seem apparent that their assumptions, dispositions, and modes of arguing actually had this effect.

At the end of the lesson, the teachers were so distressed by the discussion that they were unwilling to respond to our efforts to debrief. We had hoped that the dialogue about psychic abilities would provide a shared experience from which we might all examine the practice of conceptual change teaching. The most vocal of the teachers, however, made clear their displeasure with constructivism, identifying it as an esoteric theory with little practical import for public school classrooms. If there were teachers in the group who were supportive of constructivism, the tenor of the discussion was sufficiently hostile to insure their silence.

Using the Internet to Assist Meaning-Making

As the result of this less-than-successful lesson, we learned a number of things about the nature of discourse and the ways that Internet use can interfere with it. First, we received an important reminder about the strength of prior assumptions. Working from a constructivist vantage, this was no surprise in a theoretical sense. But we did not anticipate the important difference between specific naive assumptions and well-formed, internally-consistent sets of assumptions based on alternate world views. In short, we found that, among many of the teachers, prior constructions of reality (and of science and also of discourse) were not sufficiently piecemeal to admit conceptual change. Rather, the coherence of their views--the religious beliefs of some of the teachers as well as the pedagogical beliefs of most of them--made them resistant to the cognitive dissonance that the lesson attempted to provoke. Put another way, the teachers' prior assumptions were sufficiently elaborate and functional as to make assimilation relatively easy and accommodation almost impossible. Thus the social negotiation that we had hoped to stimulate was rejected because it stood outside of the belief systems of the teachers. In a very real sense, discourse of this type did not exist for them.

Obviously, the clash of belief systems characterizes all discourse, not just the discussions that the Internet permits to take place. But, because of their nature, virtual discussions in virtual communities may pose particular dangers to discourse in general. Unlike physical communities, virtual ones share no common ground in the very literal sense.2 Grounded in other shared purpose (e.g., the cultivation of a neighborhood that

belongs to everyone), physical communities allow multiple perspectives to exist side by side, interacting and having cross- influences over long periods of time. Members of physical communities have some stake in maintaining a peaceful way of life, and they offer shared activity as a solace for the losses encountered in clashes over belief. But the stakes in virtual discussions are not very high, and the requirements for mannerliness are, therefore, formal rather than implicit. Furthermore, in the absence of the physical encounter, virtual discussions reduce all discourse to mere words. The relationship between words and a way of life is lost in this forum. This loss is important because it reinforces the already rampant alienation and narcissism of our late twentieth century society--supporting the logically insupportable argument that all beliefs have an equal claim to truth, that all values are equally good, and that personal inclination is the final arbiter of both truth and merit.

Added to this disturbing circumstance are other features of virtual life that we observed to become animated in the lesson on psychic phenomena. Important among these features was the tendency of the Internet to disable efforts to distinguish between reputable and disreputable sources of information (see e.g., Burbules, 1996). Almost anyone can have a web page, and almost anyone can post a message to a discussion list. Moreover, these artifacts can take the form of very credible-looking products. At the same time such products need not contribute anything of substance; they can mislead unintentionally or intentionally.

Some commentators suggest that this feature democratizes discourse, and it may indeed have this effect; but the caveats necessary to accommodate this type of democratization may be so intrusive as to inoculate all discussion from credibility. Without having traditional sources of intellectual authority to rely on, one might as well invent reality capriciously. An alternative, of course, is to hope that everyone will become sufficiently knowledgeable, critical, and sophisticated so as to be able to distinguish routinely among the multiplicity of competing truth claims. From our experiences with this lesson, however, we suspect that a third strategy may have wide currency: In the face of multiple, incompatible, and seductive truth claims, people may very well do what the teachers in our group did--retreat more deeply into their previously held belief systems, shield these systems from intellectual challenges, and refuse to entertain serious argument across assumptions.

Implications for Science Teaching

The approach taken by the teacher-leaders with whom we worked effectively removed them from discussions about the nature of science and scientific claims (cf. Pomeroy, 1993). These discussions, however, may be critical to informed practice of science education since they implicate both the method and the findings of science. Scientists--no matter what their take on the "science wars"--avoid the naive claim that science establishes an infallible canon of natural law. Notably, proponents on either side of the debate promote more subtle and sophisticated views of science than our teacher-leaders were willing to entertain. This circumstance is more troubling than the "science wars" themselves, which, after all, entail thoughtful, dynamic regard for an important realm of human inquiry.

At a time when science teachers need to be increasingly careful in sifting through vast arrays of information, reliance on established "fact" seems to be a most unfortunate anachronism. Encouraged to accept constructivist aproaches, science and math teachers still cling to traditional rote and text-based methods (Besvinick, 1988; Gess-Newsome & Lederman, 1991; Stigler & Hiebert, 1997). Although structural constraints clearly do

keep science and math teachers from changing their instructional methods to incorporate constructivist practices (e.g., Keiser, & Lambdin, 1996), our investigation suggests that their prior beliefs about science teaching and about the nature of science itself may constitute another--possibly more formidable--impediment to change.

Notes

1. The authors wish to acknowledge the National Science Foundation's support for the West Virginia K-12 Ruralnet project (NSF 95-50017) and the research conducted in conjunction with that project.
2. We appreciate and agree with the comments of a reviewer of the article who reframed our distinction between real and virtual communities more broadly to encompass the distinction between real communities and arbitrary groupings of people (e.g., in classrooms, in the work place, on the freeway).

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