Debating Global Warming in Media Discussion Forums: Strategies Enacted by "Persistent Deniers" and Implications for Schooling

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Abstract

Newspapers and other media are often used as a source of information on science issues, both by the public and teachers in classrooms. Over six months, we collected discussions of global warming issues from the online forums of a national newspaper. Our analysis of these contributions suggests there is a considerable effort in these forums, especially from certain individual posters, to detract from the arguments in support of global warming by using a variety of strategies. This paper summarizes strategies employed by these frequent posters and discusses how we see many of them emerging from traditional classroom science environments.

Résumé

Le public de même que les enseignants dans leur classe utilisent souvent les journaux et les autres médias comme source d'informations sur des enjeux scientifiques. Pendant six mois, nous avons recueilli des discussions sur des sujets de réchauffement climatique dans les forums en ligne d'un journal national. Notre analyse de ces contributions donne à penser qu'il y a un effort considérable dans ces forums, spécialement de certains participants et par des stratégies diverses, pour nuire à l'idée qu'il existe un réchauffement climatique. Cet article résume les stratégies utilisées par ces nombreux affichages et commente la manière dont nous les voyons émerger dans une classe traditionnelle de science environnementale.

Keywords: public understanding of science, global warming, media, science education

> The development of the ability to read science text, which relies on an understanding of its structures and organization, begins with formal education and the science textbook. (Penney, Norris, Phillips, & Clark, 2003, p. 417)

Most environmentalists would argue that one of the most critical issues facing us today is global warming.[1] Yet, awareness in the public that an immediate response is needed has been slow to develop, arguably leading to the slow reaction of political figures, as there is little benefit for them in

forwarding a proactive agenda without broad public support (Morgan & Dowlatabadi, 1996). Where does most of the public get its information about topical science issues? Overall, it appears that the media is a major source of science information (Boyes & Stanisstreet, 1992; Dispensa & Brulle, 2003; Lewenstein, 2001; Schibeci, 1990), and given the media presence on the web, this may well continue to be the case. Biases in the media presentations of global warming contribute to public misunderstanding (Boycoff & Mansfield, 2008; Dispensa & Brulle, 2003), and negative media portrayals of science and scientists reduce public trust in science (Liakopoulos, 2002).

An analysis of the presentation of scientific knowledge on global warming to the public over the last two decades concluded that the media's attempt to provide "balance" by focusing on "controversial aspects of climate change science" (McBean & Hengeveld, 2000, p. 11) as a debate amongst scientists has led to a "public perception of scientific uncertainty that significantly exceeds that perceived within the scientific community itself" (McBean & Hengeveld, 2000, p. 11). Misunderstandings of climate change science by members of the media contribute to this public confusion about the science behind climate change (Boycoff & Mansfield, 2008; McBean & Hengeveld, 2000). Even relatively knowledgeable reporters (as compared to general reporters) belonging to the Society of Environmental Journalists "created dissent in areas in which science agrees" (Wilson, 2000, p. 11). Canadian media, where the majority of science journalists in print media do not have a science background themselves and focus primarily on science policy rather than science itself (Saari, Gibson, & Osler, 1998), is unlikely to be different. These are significant issues, given the relationship between the media and the formation of public policy (Nisbet & Lewenstein, 2002).

Although there is a long history of so-called public debates over socioscientific issues, in reality it is not the "public" that has been engaging in these media debates. The idea that there has been a "public" debate is premised on the exchange of views between comparatively few individuals taken to be speaking for "the public." However, these individuals were chosen to participate by those who ran those media, thereby serving a gatekeeping function (Dispensa & Brulle, 2003). This is not to suggest that the media misrepresented the issues, but the very act of choosing one or two people to present information meant that the nature of the debate was framed by only a few individuals. The tendency of the media to dramatize conflict or uncertainties in science claims for the purposes of selling papers (Neidhardt, 1993) makes it more likely that the views expressed did not represent those of the general public.

In the past, with some exceptions, broad public debate on topics, unfiltered by the media, was infrequent. The Internet, however, has changed this. It is now possible for any member of the public to have available a vast amount of information about, and form opinions on, any topic by merely using a search engine. Thus, the Internet has provided both a broad swath of

information to the public and a venue for contributing to discussions of these issues through, for instance, public discussion forums.

The formal media (i.e., print newspapers, magazines, radio, and television) has adapted to this changing informational world. Content and commentary are now provided in several ways, including through articles posted online, through columnists' web logs ("blogs") in addition to their published articles, and via streamed versions of broadcasts and podcasts for download. In the case of radio, television, and newspapers in Canada, the media also provides the opportunity for the public to comment on news items using online discussion forums. These forums provide the opportunity for readers to respond to news items directly, as well as to offer alternative claims, evidence, and resources in attempt to persuade other readers to adopt particular positions.

Online discussion forums, particularly those that are prominent (e.g., appended to articles published by a national newspaper), offer a particularly interesting window into public perspectives on global warming. This is not to argue that such a forum is necessarily perfectly representative of the public view, but it does offer a different sampling of individuals and a different dynamic than might normally be encapsulated by other research methodologies designed to assess public opinion (e.g., surveys, personal interviews, and phone interviews).

In this paper, we present our analysis of participation in public discussion forums, focusing specifically on forums associated with published newspaper articles that reveal the "denier" perspective—the perspective of individuals who argue against global warming existing and/or being anthropogenic in nature, and/or those who believe that setting policy to address global warming will have a negative impact—to determine what might have led to the deniers adopting the positions they held. We argue that, rather than being merely an informational issue—where the public does not know or understand the content of the claims about global warming—the issue is more complex in that the public engagement in the global warming forums represents an *interpretation of information* issue, wherein the interpretation has been biased by a public (mis)perception regarding the practices of science. We further argue (consistent with Penney, Norris, Phillips, & Clark, 2003) that schools have some culpability for developing that perception through the practices by which they have traditionally taught school science. We conclude that the evidence suggests that one change which could improve public understanding of issues such as global warming, before they reach the crisis point (such as is ostensibly now being faced in relation to global warming), is a re-formulation of how we teach science in schools.

Methods

We reviewed the web site of one national newspaper approximately once each week in the fall of 2006, and then approximately three times per week

between January and April 2007. Articles dealing with Global Warming (or claiming a connection to it) were archived. Appended discussion forums were archived either after comments were "closed" by the newspaper, or after 24 hours passed during which no new posts were added. Forums were usually semi-moderated, so some comments were removed during the time the forum was open for posting. Thus, our database (of almost 3,000 postings appended to 25 articles) may not contain all original postings.

Using an Interaction Analysis approach (Jordan & Henderson, 1995) informed by grounded theory perspectives (Strauss & Corbin, 1990), we individually analyzed postings in two steps. First, we identified posters deemed to be "persistent deniers." These were individuals who both posted repeatedly for a single article and for multiple (>3) articles, either rejecting that global warming was occurring, that it was anthropogenic in origin, and/or that any changes needed to be enacted to address it. Currently, our list of "persistent deniers" is comprised of 26 individuals who were responsible for 656 postings (out of 798 total posters and 2923 total posts).

We then individually read all of the postings, noting the various strategies used to argue against global warming. After individually constructing categories, we met in a joint session and compared our individual assertions (with examples). We constructed final agreed-upon categories, and descriptions of them, in this session. We then re-examined the database for confirming and disconfirming cases, and refined our category definitions as necessary. Our final claims, implications, and categories arose from several such iterations.

Findings

From our analysis we identified eight strategies frequently employed by persistent deniers. These strategies were used to dissuade other readers from accepting claims made in the articles about global warming. In the following section, we describe these strategies and provide examples from the forums. We then discuss changes in argumentation approaches preceding and following the February 2007 release of the Intergovernmental Panel on Climate Change report: *Climate Change 2007: The Physical Science Basis: A Summary for Policy Makers* (IPCC, 2007).

Strategies for Arguing

Dissuasive strategies used by deniers in arguing against global warming were: ad hominem attacks, warnings of economic downfall, deflections to other issues, referrals to other "authorities" who argue against global warming, references to other disconfirming evidence, references to the uncertainty expressed by scientists, accusations of media/journalist bias or incompetence, and statements of denial.

Ad hominen attacks. Ad hominen attacks are personal attacks against the individuals involved in making a claim. These types of attacks were frequent, and usually phrased to undermine the integrity of the individuals making claims, thereby undermining the claims. These included statements such as:

> (a) Sure, and the "scientists" don't have a vested interest in this being a catastrophic problem that requires billions of dollars to go to experts for additional studies and tech research?
>
> (b) Posterity will laugh at this latest doomsday Cult as one of the biggest hoaxes perpetrated against ignorant, guilt-ridden loons searching desperately to find something to believe in to ease the emptiness in their hollow souls….A flawed computer model promoted by the Goracle and his Apostles just won't cut it.

Economic downfall. Deniers often suggested there would be an economic downfall if global warming was addressed through CO_2 reductions. This argument was occasionally framed in relation to economies of other nations (e.g., China or India, which have not committed to lowering their carbon emissions), and how these nations would simply compensate for our reductions by producing goods to replace those we do not. Alternatively, commentary was framed in the context that, as Canadians, our carbon contributions are comparatively quite small, and that destroying our economy for minimal changes in global carbon contribution makes little sense:

> (a) Kyoto is a waste of time if the two biggest polluters don't come on board. Yes China and America aren't signatories, so until they sign up all that the rest of the world is doing, which is commendable, is a waste of time and money. China and America, to fuel their economies, so they can buy weapon's [sic], will damage the earth beyond repair, kind of ironic isn't it.
>
> (b) At the end of the day, we can do our part, yet unless the "Big Boys" (USA-China-India-Brazil-Australia-Turkey) get on board, our cuts and contribution is meaningless. So before we go wrecking our economy in vain for the flavour of the day issue, let's take a step back and make sure all major countries are on board with equal responsibilities!

Deflections to other issues. Attempts to deflect concern about global warming to other issues were frequent. Deflections focused on issues such as those involving the environment (e.g., smog pollution), biological concerns (e.g., species loss, need for stem cell research for disease reduction), social issues (e.g., homelessness, hunger, quality of living on First Nations reserves), and political concerns (e.g., political scandal, non-representative nature of party power):

> (a) This issue will cause tremendous financial hardship to many people for NOTHING. I won't stop until this Swindle is exposed for what it is—an idiotic attempt to stop natural climate change. The money and energy wasted on this

topic, put towards REAL pollution would give a better and REAL return on investment!

(b) World population a century ago, about 1 billion, world population today, about 7 billion (12 billion by mid-century)… This then is the real problem facing mankind [sic] today (for you global warming fanatics), too many people taxing the resources of the planet, both energy and biomass.

Referral to other "authorities." Deniers frequently deferred to other authorities who argued against global warming. These authorities frequently fell into the category of "pseudo-expert" (those who have a science background outside of climatology) or "non-expert" (those who have little or no science background at all) (see McBean & Hengeveld, 2000). Their arguments are often considered to be specious by scientists involved in climate change research, or are focused on details considered to be irrelevant or non-significant in the overall picture. Frequently, these individuals have financial backing which, when researched, extends from those with vested interests in arguing against government policymaking to reduce carbon emissions (e.g., oil and gas companies):

Might I recommend the work of [*name removed*] who is often maligned by the Suzuki group and other green peacer [sic] types who has done some excellent work on solar flares etc. and their effect on the earth's weather.

Reference to disconfirming evidence. A frequent strategy was to refer to what the poster claimed to be disconfirming evidence—often a single study or observation—which was then taken by the poster to refute *all* claims of global warming. This type of approach also occasionally conflated terms such as "weather" and "climate" to argue that global warming is not occurring:

(a) Data going back hundreds and thousands of years do not support the theory that CO2 has any effect on global temperatures. Al Gore might have a nice graph to show that they rise and fall in a similar nature...unfortunately the rise in CO2 as evidenced by ice cores ALWAYS lags the increase in temperature by a few hundred years. The "cause and effect" is that higher temperatures create more CO2 in the environment...not the other way around. Data going back hundreds of years which correlate the occurence [sic] of sunspots to global temperature correlate quite nicely. Has to make you wonder what effect the number of SUV's has on the sun's core activity.

(b) "We are between 90% and 95% certain that in the last 37 years there has been a warming trend"…Just imaging their report if this was 1930, and we had the prairie dust bowl and drought. There was no global warming in the 1930's and the forecast is the same as today. Major prairie droughts occur every 60 years on average, and we are overdue. Cycles happen.

Uncertainty expressed by scientists. Many denier posters used hedging language (Hyland, 1996; Lakoff, 1972—which is normally used by scientists to

contextualize claims—as an entry point to critique scientific claims. In essence, if statements were made supporting global warming that were other than completely certain (such as those found in Intergovernmental Panel on Climate Change reports), they were used by deniers to suggest that no credence should be provided to the claims at all:

> (a) I don't remember ever reading an article in which the word "could" was used so often. No clear statements as to what will happen because they just flat don't know.
>
> (b) No one argues that there is not a warming trend. The argument is found within whether or not warming is anthropogenic (manmade) or not. Based on what I am reading in the IPCC [Intergovernmental Panel on Climate Change report] all I am seeing is that there is a consensus on the fact we are in a warming period, but very much a split on whether it is caused by humans (or whether it can be changed by humans).

Accusations of media/journalist bias or incompetence. Despite the evidence that media presentations of global warming have all too often provided illusory credibility to the arguments against global warming through the seeking of "balance" by quoting scientists on both sides of the argument, some posters argued that the media did *not* do so and thus were trying to stifle debate about global warming. Another aspect of this type of argument against global warming is attacking the journalists themselves as being biased or unable to understand the science, as a consequence of which they are representing a misleading perspective on global warming:

> (a) This global warming scam is nothing but media hype. It sells papers and the environmentalists receive funding. The weather is changing? YES! It is always changing and it is the sun that has the most influence on this planets [sic] weather.
>
> (b) The scientific analysis presented in [this newspaper] badly misrepresents the state of the peer-reviewed world. People who think they know climate science from what is presented in the mainstream media are simply delusional.

Outright denial. A final approach (again, often combined with others) involved the use of outright denial that global warming was occurring, without offering justification for this position:

> (a) Anyone who lives in BC knows there is no green house gas problem here. The rain forest cleans the air very well thank you very much. …. For me global warming is a non-event.
>
> (b) This Global Warming stuff is really a lot of nonsense. Something for the Toronto no-minds to get involved with. Now they have another "cause." Go worship Gore and Suzuki you humanist dingbats!!!

Overall, many of the posted commentaries included several of the above strategies in a single post. A post could include ad hominem attacks, deflection to other issues, use of dissuasive evidence, and other strategies not discussed here in detail, such as the politicization of the issue and claims of historical inaccuracies.

When one reads the denier postings across multiple articles, two features stand out. First is the frequency with which they appeared in the forums (656 postings out of 2923 total posts). Second, particularly with the so-called "factual" arguments against global warming, the reader is struck by the number of times the same individuals post the same commentary for multiple articles over many weeks, sometimes even months. Even though the foundation of their points (or the "authorities" to whom they referred) was seemingly effectively critiqued by other posters, those same "authorities" and arguments were returned to again and again. After reading thousands of postings, we concluded that the persistent deniers were not motivated by a desire to learn more about global warming (and possibly reframe their perspective), but were posting with the intent of persuading the unknowledgeable and casual reader that the associated article, and hence global warming, was not to be taken seriously.

Changes in the Arguing Strategies Over the Long-term

Although there were rarely changes in viewpoints held by persistent deniers in the short-term (within or across several article forums), irrespective of what counter-evidence was offered, there were some changes in arguments over the longer term as the evidence against a specific argument became overwhelming—such as with the release of the February 2007 Intergovernmental Panel on Climate Change report (although this document also provided other fodder for critique). Whereas arguments at the beginning of the study tended to focus on whether global warming was actually happening, with the release of the Intergovernmental Panel on Climate Change report, arguments shifted towards the stance that temperature change was not anthropogenic, while at the same time various other strategies to discourage acceptance of the report as being valid were adopted. These included statements such as:

> (a) It's too late for us to do anything so we may as well carry on as we are.
>
> (b) May be happening, but there is no evidence that it is anthropogenic in nature, so destroying our economy to address a natural process doesn't make any sense.
>
> (c) Since we are such small contributors and Country X, Y or Z is so much worse, even if we do something it will have no effect so we may as well not destroy our economy.

The eight earlier categories of dissuasion continued to be used, but the deniers directed arguments less at whether global warming itself was occurring and more against the claims that global warming was anthropogenic in origin.

Discussion and Implications

What do we learn from studying the arguments used by persistent deniers to try to persuade readers that attending to global warming with any immediacy is unimportant?

Much of the public reaction to global warming, particularly the negative reaction, is attributed to a deficit model of the public knowledge—particularly in relation to the details of the public understanding of the "facts" underlying scientific claims. Although it seems perhaps most straightforward to lay the blame for a lack of action on climate change and a continuing resistance to accepting arguments for it on a lack of knowledge about the issue (McBean & Hengeveld, 2000; Pruneau, Liboiron, Vrain, Gravel, Bourque, & Langis, 2001), we believe the data from these forum discussions reveals a more complex picture. We have concluded that the issue hinges less on a lack of understanding of climatologists' claims regarding global warming, and more on the *lack of an appropriate interpretive framework* for making sense of the knowledge held.

Many of the strategies used by persistent deniers, including ad hominem attacks, warnings of economic downfall, deflections to other issues, accusations of media/journalist bias or incompetence, and statements of denial, are arguably ones that could be addressed in any class subject from the perspective of critical thinking, argumentation, and problem solving. There are other strategies, however, that may be more specifically related to the learning persistent deniers experienced in school science. First we will discuss our conclusions from the perspective of the ways in which scientists discuss *uncertainty* through the use of hedging language, the manner by which *refutational evidence* is dealt with in science, and, finally, understandings of how *authority* is constructed in science. For each we discuss practices enacted in science classrooms that we believe contributed to the development of this interpretation framework, concluding with a discussion of the implications for the teaching of school science.

Uncertainty

Making statements that indicate degrees of uncertainty is the norm in science, not the exception. Written claims in science are often probabilistic statements that indicate the degree to which the authors are certain about the strength of a claim, but generally such statements are not taken as an indication that the authors doubt a relationship exists. Research writing is a form of writing

in which one is proposing ideas to one's discourse community to be evaluated and (one hopes) accepted. It is a unique style of writing that involves terminology that expresses these degrees of uncertainty—in other words, hedging language (Hyland, 1996; Lakoff, 1972). Such use of hedging language is particularly characteristic of research writing that deals with new knowledge (Myers, 1989).

In the forums, stated uncertainty about global warming patterns or trends were utilized by persistent deniers to suggest that if the scientists cannot be certain of their facts, then global warming is unlikely to be occurring—or, more recently, unlikely to be anthropogenic in origin. Statements using hedging language, which, as pointed out, is common in science research writing, were thus used by persistent deniers to *completely* reject arguments for global warming.

We suspect that, to some extent, the teaching of science in schools has influenced this interpretation of scientific claims by the public, particularly that segment of the public studied here. School science laboratory activities are almost always designed to confirm known outcomes; therefore, students implicitly learn to expect that an unambiguous outcome or relationship will emerge from such activities and that there will be a strong correspondence between the variables. This also means that students are unused to hedging statements. Apart from school experiences with unambiguous single-variable studies, students also spend a considerable amount of time reading textbooks (up to 75% of classroom instruction and 90% of homework is based on the textbook—Lumpe & Beck, 1996; Spiegel & Barufaldi, 1994), even though "textbooks may fail to develop the critical skills needed for students to become scientifically literate adults" (Penney, Norris, Phillips, & Clark, 2003, p. 431). The language in textbooks differs considerably from that in research writing, because textbooks deal almost exclusively with deterministic propositional knowledge accepted unreservedly by the discourse community from which it emerged (Crompton, 1997). Thus, students' experiences with relationships between variables and with their reading of textbooks provide them (and future adult participants in discussion forums) with few resources to understand claims about stochastic multi-variate systems, and little experience with reading the knowledge claims made by scientists about such data. We suggest that the strongly deterministic language used in school science (e.g., "A is correlated with B" —implying a direct and absolute one-to-one correspondence) undermines claims from real-world data which are often stated less strongly, thereby explaining some of the discourse strategies used by persistent deniers.

Refutational Evidence

Intertwined with the issue of misreading statements of uncertainty in science is the apparent misunderstanding of how scientists view refutational evidence.

Science theories (and subsequently laws) develop over a considerable period of time. They develop as a consequence of research and writing by a number of individuals across different research settings. This development process occurs through individual researchers or teams collecting data, presenting it to peers in various formal (conference) and informal (seminar) settings, refining their interpretations, and finally publishing the findings through a peer-review process, in a manner wherein the findings are presented along with a framework for making sense of them (often a theory-based framework). Over time—as more studies are completed, more findings are made, and more data is understood—theories are gradually refined and modified to fit most of, but not necessarily all of, the data. The process of developing theory in science is thus dynamic and incremental. Roth and McGinn (1999) conclude that "scientific knowledge emerges from a nexus of interacting people, agencies, material, instruments, individual and collective goals/interests, and the histories of all these factors" (p. 15). However, an understanding of this development of scientific knowledge is little conveyed by traditional science teaching approaches.

In the global warming discussion forums, any "refutational" study (one which contradicted or had elements which did not correspond with the broad claims about global warming) was used by persistent deniers to reject the claims that global warming was occurring *in toto*. Evidence used to support the deniers' claims could be as little as a non-increase in global temperature in the past six years, for which they would offer up as evidence a graph published by a meteorological service of average global temperature. Even counter-arguments to these datasets from other posters were not dissuasive to deniers, who argued that such single cases were sufficient for rejecting the entire idea of global warming.

To further understand the role that schools may have played in the development of the interpretive framework used by "persistent deniers," we again reflect on features that characterize typical classroom science activities. Classroom science laboratory investigations have traditionally involved students conducting prescriptive laboratory activities that are confirmatory of the univariate relationships represented in textbooks. This type of confirmatory investigation activity is only minimally related to the complexity of relationships found in the science of global warming and, we argue, does an ineffective job of preparing students (and subsequently, adult members of the public) to deal with complex multivariate issues found in phenomena such as global warming.

Even when students are engaged in more open-ended inquiry investigations, most of the time they: propose a hypothesis involving a single variable, design the methodology (although this is less frequent), conduct the investigation, collect data, interpret the data, and then either draw conclusions which flatly accept or reject the hypothesis, or draw no conclusion at all. This hypothetico-deductive type of activity implicitly portrays a model of sci-

ence which reaches a firm and precise conclusion about outcomes and relationships. It is unlike many of the more complex relationships with which scientists actually deal. Even high school textbooks overwhelmingly portray a world of firm conclusions drawn from nominal and ordinal variables, unlike the interval-ratio variables which dominate science relationships (Bowen & Roth, 2002; Roth, Bowen & McGinn, 1999). Further, traditional school science creates a misunderstanding regarding scientific theory and "fact." Hodson (1998) makes it clear that this issue is an important one:

> [T]heories are only abandoned when there is compelling evidence (long-standing and striking at the fundamental core of the theory)… It is misleading to present students with the idea that theories are abandoned because of a few negative results. In practice, all theories have to live with anomalous data; it is a natural feature of science. We seriously mislead students when we pretend that the kinds of experiments they perform in class constitute a straightforward and reliable means of choosing between rival theories. (p. 194)

The persistent deniers frequently evidence these very issues in their comments through their use of individual cases which they believe run counter to the published evidence, which they then use to reject any claim in support of global warming.

Authority

In the scientific community, one's authority to speak on a topic derives from one's academic record on the topic. This determination of authority is established using a number of criteria, including experience doing research in that domain or a related one, publication record, conference presentation record, academic lineage (who the doctoral work was done with, and at what institution), the research group involved, and the academic institution at which the individual is employed. No one of these individually negates the others (for instance, one can work at a small institution and still be considered quite senior in the discipline), nor does one issue overwhelmingly override the others positively (e.g., working at a well-regarded institution does not mean you will be considered an authority on a topic). However, in the collective, the more highly one is regarded in each of those areas, the more one is considered to be an authority whose claims carry credibility.

Concerning the persistent deniers, a further issue is their understanding of this scientific authority in their evaluation of knowledge claims related to global warming. We concluded that there often appeared to be considerable difficulty understanding how the validity to critique science *as* a scientist is established. In the cases discussed in this paper, it is clear that persistent deniers attributed considerable authority to numerous individuals whose expertise about global warming was, at best, only in peripherally related disciplines. However, the claims of these individuals were often taken as being

equally weighted with those of scientists who study and publish frequently on the topic. Without entering into the debate of the appropriateness and validity of critique within and across disciplinary boundaries within science itself, the credibility ascribed to these individuals (and organizations) by a lay public would appear problematic in that far greater authority is attributed to their critiques outside of science communities than is afforded it internally.

In one online discussion forum, a denier submitted a quote attributed to an individual who the denier identified as a university professor with appropriate expertise for making such claims. The quote denied global warming was occurring and the poster accepted the claim based on his or her understanding of the person's academic credentials. Through a series of postings, this individual's credentials (as obtained through the Internet) were held up to public view—by someone arguing in support of global warming—and considerably critiqued through successive posts as insufficient to make such a comment with any academic credibility. This search revealed that the individual making the claim about global warming held a master's degree in meteorology (which seemed to be a course-based degree), was a lecturer (not a professor) in weather forecasting (and not climate) at a small university, and had presented talks at regional meteorological meetings but had never published on climate issues in any journals or presented papers on the topic at any conferences. This person thus meets the criteria of *pseudo-expert,* as described by McBean and Hengeveld (2000).

It is interesting to examine the manner in which authority in science compares to that found in schools. We will comment on this from the perspective of individual teachers as well as the perspective of grading knowledge statements in assignments. First, in a school, a teacher need do nothing other than be hired for the institution to insist to students that she or he should be taken to be as much of an authority as any other teacher. Teachers do not *earn* authority from the perspective of students, but both claim to have it (directly and implicitly to students) and are afforded it by the school itself. Students are expected to give as much respect to a first-year teacher as an experienced one, or to a teacher with a Bachelor of Education as to a teacher with a Master's degree (or a PhD; neither of which the students will generally have any idea about). In the classroom, and very much unlike in the scientific community, there is also but that single authority determining the legitimacy of the students' knowledge claim—the teacher is the lone arbiter of what is acceptable knowledge. Within that teacher's evaluation of school work is embedded the view that there is a "correct" answer—again, very much unlike science, where there is no such absolute determination. In schools, we thus have a knowledge-verifying authority about whom students (or parents) get to make no informed determination or critique regarding the merit of their credentials.

Considering the time over which schools reinforce this framework for thinking about intellectual authority, it is unsurprising that there appears little or no attempt by deniers to determine the relevance of the credentials of

those who make claims about global warming. One voice is, in the views of persistent deniers, of equal authority to any other. We suspect that models of authority in schools contribute to this, particularly in subjects such as science classrooms within which "new" knowledge is created and the teacher acts as the arbiter of acceptance.

Coda

From our examination of the discussion forums, we have concluded that, rather than representing any misunderstanding of the facts themselves by persistent deniers, the rejection of the claims of the Intergovernmental Panel on Climate Change scientists (and others) regarding global warming emerge instead from a misunderstanding of how authority is constructed in science, how claims emerge from relationships, and how hypotheses (and theories) are accepted, refined, rejected, et cetera. We further conclude that the manner in which school science is taught contributes to the development of these misunderstandings in the general public. Why do we surmise that it is the interpretive framework of the persistent deniers that has primacy as a problematic issue? Because the persistent deniers were consistently unswayed by new sources of information in a series of posts, by clarifications, by more in-depth interpretations of information in the Intergovernmental Panel on Climate Change reports, or by further supportive data sets, reports, or published papers. No matter what critiques or evidence were offered, they often continued to afford authority for claims about global warming to individuals who would, in the scientific community, be considered to lack sufficient credentials. They did not find new information persuasive (from article to article), yet deniers conveyed that they were intelligent and thoughtful adults through how they were arguing. Given this, we are persuaded that it is a lack of understanding of the context in which such claims are constructed that led to their rejection of the arguments supporting global warming, a conclusion consistent with arguments made by others (Reis and Galvao, 2004; Ziman, 1984).

Issues such as we have described here are by no means exclusive to global warming. Similar strategies have been used in discussions of other socioscientific issues, such as the use of this type of resistance and argumentation by the tobacco industry about the perils of smoking (McKeown, 2006; Roth, Dunsby & Bero, 2003) and the argument around "safe injection" sites in Vancouver (Maxwell, 2007). Overall, this highlights the importance of developing scientific literacy in students, for it is these students who become the adults who will argue in public discussion forums of the type studied here. And, if current trends continue, such forums will become more frequent as society becomes more computer literate and comfortable with online discussions. Given that Dispensa and Brulle (2003) clearly identify that media coverage in North America, in contrast with other countries, dissuades the public from taking global warming seriously by presenting it as controversial

and theoretical, we are left to wonder: if the public understood more about the practices of science regarding claim construction and the social practices related to it, would this have been possible? We suspect not, because they might well have been asking more probing questions about the strategies used in these media sources.

How might we address this issue of lack of understanding of the context in which science is done? Hodson's (1998) discussion of the disservice done by school science with respect to dealing with refutational evidence suggests there would be advantages to engaging students in working with data that has the "messiness" inherent in real-world data sets, so they can learn that imperfect relationships, and the hedging language used to describe them, is a standard part of science and not a foundation for rejection of claims. Despite the argument that can be made that more scientists should participate in the public debate (such as we have described it), given the experiences of those in science who have done so that we are aware of (via unpublished data), our overall conclusion (and that of others, see Bowen, 2005; Woolnough, 2000) is that students (and their teachers, see Bowen & Bencze, in press) need to participate in self-directed, open-ended inquiry investigations as part of their science class in a fashion not dissimilar to the activities described by Pruneau et al (2001). This would allow students to develop a better understanding of the social negotiation practices of science, the complexities of multivariate systems and the nuances of relationships that emerge from them, and the manner in which science claims are "hardened" (Latour & Woolgar, 1986). In part, activities of this sort hold the promise that students will learn that useful insights can be gained from investigations when uncertainty about high correspondence between variables is present (the lack of variation from the confirmatory relationship in typical laboratory investigations is, in this context, a considerable problem), and that including direct teaching on the nature of science and its practices would "provide a good preparation for future engagement with socio-scientific issues" (Lewis & Leach, 2006, p. 1283). Given the parallels in the approaches used by persistent deniers to sway public opinion on global warming and the practices of school science, using open-ended investigation approaches in classroom science might well result in a public capable of participating more effectively in public discussions of environmental and other socioscientific issues because they will have a better foundation for making sense of scientists' claims.

Notes

[1] Our use of the phrase "global warming" instead of climate change is (a) consistent with the majority of usage in the forums and the associated articles, (b) consistent with the majority of usage by the senior climate scientist we interviewed, and (c) counter to the desired usage by the "per-

sistent deniers," who prefer the phrase "climate change" over "global warming" because the concept of the climate changing seems less controversial, and therefore feeds into their argumentation and goals of dissuasion about global warming.

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