Scientific and Ethical Literacy in Authentic Public Comments in Online Climate Change News Coverage

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Abstract

Little is known about the ways in which scientific literacy manifests itself in authentic everyday situations among adults. Here we investigate scientific literacy as expressed in authentic reader comments to climate-related online coverage in a news website. 648 reader comments were analyzed for use (regardless of quality) of science concepts, perceptions about the nature of science and the scientific methods, position towards climate change and ethical stances. The findings indicate more expressions of scientific literacy in comments opposing the scientific consensus. The traditional deficit model considers public disagreement with scientists to be associated with ignorance. However, this finding may be better explained by readers' distrust of the scientific process and establishment rather than their knowledge.

Keywords: Scientific literacy, readers' comments, climate change, ethics.

Conceptual framework

Education for informed citizenship, knowledge-based decision-making, and application of scientific knowledge and ways of thinking to everyday life are the main goals of the science literacy movement (Ryder, 2001). Feinstein (2011) argues that research on 'public engagement with science', and specifically the ways in which laypeople become involved in science, could serve as a basis for a new conceptualization of scientific literacy. Currently, little is known about the ways in which scientific literacy manifests itself in authentic everyday situations among adults. We investigated scientific literacy as expressed in authentic reader comments to climate-related online coverage in a news website.

Climate change is a preeminent issue on the public agenda (Bowen & Rodger, 2008). Recent public discussions on the topic do not usually focus on whether climate change is happening, but rather which human actions or natural phenomena is the cause. Although 97.1% of scientific articles endorse the position of anthropogenic global warming (Cook et al., 2013), the issue is controversial among the public and only 49% of the U.S. accept the anthropogenic causation of climate (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). Awareness to the issue does not entail agreement with the scientific consensus. In Israel, where this study takes place, 86% of the public is aware of climate change, of whom 63% think it is caused by human activity, and 62% perceived it as a threat (Pelham, 2009).

Objectives

This study analyzed the scientific and ethical content of reader comments to articles on climate change on a leading online news site. The relationship between the position of the comments regarding the cause of climate change, and expressions of scientific literacy as seen in the use of scientific concepts, inquiry skills, nature of science conceptions and ethics were explored.

Methodology

Data sources: *Ynet* is the most popular Israeli news site and reaches 63% of all Israeli surfers (TIM., 2013). It has a well-developed reader comment system, a phenomena more dominant in the Israeli media, compared with other countries (Goldshmidt, 2006).

Sampling: For six months (October 2011 – March 2012) sections of *Ynet* were examined for climate change related coverage, yielding 22 articles, presented different positions towards the issue, and 1,059 reader comments. The five articles with the highest number of reader comments were chosen for analysis, totaling 648 comments.

Analysis: The national Israeli biology curriculum was used as an analytical framework to characterize its real-world suitability as a provider of scientific literacy. Content analysis of the articles and reader comments were guided by the goals it defines: Knowledge, Inquiry skills, nature of science (NOS) perceptions, and setting informed positions. We also looked at ethical expressions.

Positions concerning the anthropogenic causation of global warming were labeled as anthropogenic, skeptical, complex or unclear. This classification analysis did not differentiate between deniers and skeptics. Inter-coder reliability for identifying the positions was established by two independent coders on 18% of the comments (Cohen's Kappa 0.87).

Scientific knowledge was assessed based on the use of science concepts[1]. Science concepts were classified according to their level in the Israeli science curricula (Israeli Ministry of Education, 2010a, 2010b, 2011, 2012a, 2012b, 2012c, 2012d, 2013a, 2013b): Elementary school (e.g. volcano); Junior high school (e.g. global warming); High school (e.g. dynamic equilibrium), and concepts at an academic level which are not found in the syllabi (e.g. particle accelerator). New concepts that were not in the articles or introduced by other readers were counted separately from recurring ones. Inter-coder reliability was based on independent coding of 15% of the items by two coders (identification of concepts - Cohen's Kappa 0.9; classification according to level – was 0.83). To describe the level and number of science concepts each comment was assigned a 'science concepts index' according to the following formula:

> ***Science concepts index for the comment*** *= (no. of Elementary school level new concepts introduced by the comment)+2×(no. of junior high school level concepts introduced)+3×(no. of high school level concepts introduced)+4×(no .of academic level concepts introduced)+(no. of reused concepts)*.

Other dimensions of scientific literacy (NOS, inquiry, and ethics) were tabulated as the amount of responses that mentioned them.

Nature of science (NOS) statements were classified according to the NOS goals of the high school biology curriculum (Israeli Ministry of Education, 2010a). Aspects of NOS include forms of scientific knowledge, tentative nature of scientific knowledge, capabilities and limitations of science, ways of reporting science, history of biology and applications, critical approach, skepticism, scientific integrity, moral, social and economic considerations. Inter-coder reliability was based on independent coding of 20% of the comments by two researchers (Cohen's Kappa 0.88).

Inquiry. The Israeli biology curriculum includes inquiry skills according to the stages of the canonical research process; namely, research questions, assumptions, predictions, hypotheses, research structure, methods, statistics, discussion of results, conclusion, limitations, and statistics. Inter-coder reliability for identification and classification of inquiry statements was based on independent coding of 20% of the comments by two researchers (Cohen's Kappa 0.86).

1 The use of a concept was coded, regardless of the quality or correctness of use.

All *ethical statements* in the readers' comments (n=554) were identified. Given the disparities between theoretical discussions of ethics and the way moral questions and problems are discussed by lay people in everyday life (Schicktanz, Schweda, & Wynne, 2012), the analysis was not based on a theoretical but rather on emerging themes from the comments, which led to five categories: (1) Emotions referring towards ethics, e.g. "hate", "enough!!!!!" (2) Ethical conceptualizations expressing principles or values, e.g. "justice", "rights", "honesty" and "saving lives". (3) Ethical reasoning, e.g. arguing for a hierarchy between values or minimizing damage. (4) Ethical authority, e.g. referring to rules established by codes of ethics, law, or religions. (5) Behavioral ethics which refers to personal practical involvement for promoting an ethical agenda, e.g. traveling by public transportation to reduce carbon footprints. Inter-coder reliability for identification and classification of ethical statements was based on independent coding of 10% of the comments by two researchers (Cohen's Kappa 0.89).

Statistics. Significant differences between groups were calculated using paired and unpaired t-tests, chi-square and Mann-Whitney tests as appropriate.

An example of analysis of a reader's comment (translated from Hebrew):

> *"The warming of our world: Temperature measurement is dependent on the location of the measurement station. A location adjacent to the city leads to false readings due to local impact. In the 70s in the U.S. there was a phenomenon of incorrect reading. It turned out that as the communities got bigger the stations that were outside these localities moved inside… Climate science today behaves just like the medieval church. Inquisition of science today is a sad evil."*
>
> *(Ronen, Comment no. 40 on the article: "Ozone hole?! Slight hiccup of the globe" published October 19, 2011).*

Position: skeptical.

Concepts index: warming (1)+ Temperature-measurement (1)+ measurement station (4)+ false readings (3)+ Climate science (1-reused concept) = 10

Inquiry skills: explanation of results (1), concluding (1), assumptions (1) = 3

Nature of science: critical approach and skepticism (1), moral and social considerations (1) = 2

Ethical statements: Ethical conceptualization (evil) = 1

Findings

Clear positions regarding the anthropogenic causation of climate change was expressed in 73% of the comments (Table 1). Anthropogenic and skeptical positions appeared almost equally. Complex positions were expressed in only five percent of the comments, and 14% of the comments did not express any opinion with regard to the cause of climate change.

Table 1. Positions expressed in reader comments to climate change coverage (n = 635)

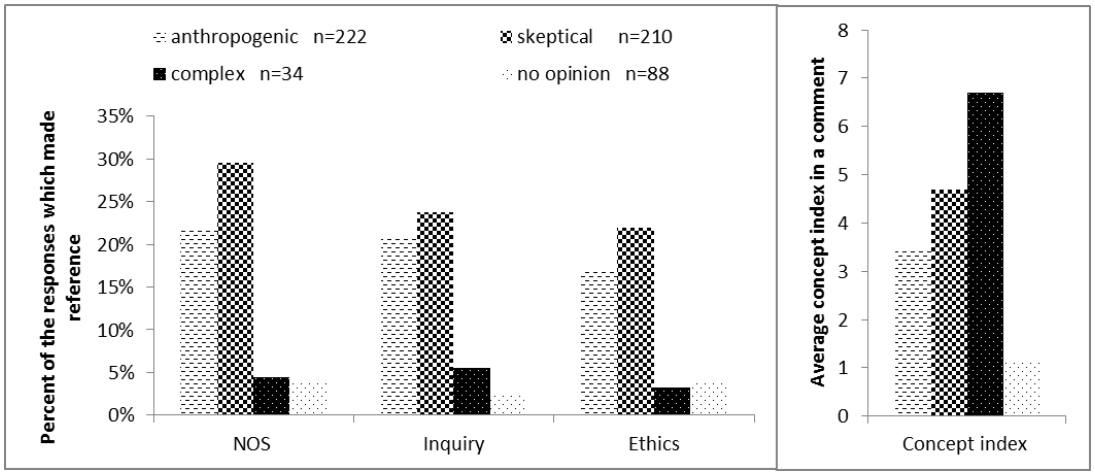
Position	% comments	Example
Anthropogenic impact	35%	*Humans have released unimaginable amounts of greenhouse gases for decades which tips the balance*
Skeptic	33%	*The climate is chaotic, uncontrollable and has low predictability*
No opinion	14%	*I also have no idea whether or not the Earth is getting warmer*
Complex	5%	*The world was much warmer in the past and much colder as well, the big question is how much we affect climate change*
Not relevant	13%	*Unnecessary article that sheds light on nothing*

Reader comments presenting clear positions used more and higher level science concepts than those presenting no opinion. The average concepts index of the anthropogenic comments was significantly lower than the skeptical ones (2 tailed paired t test $p < 0.01$, $t_9 = -3.1$). Complex views were expressed using the highest concept index, whereas comments with no opinions yielded the lowest concepts index (Figure 1).

Phraseology concerning the Nature of science were significantly higher in skeptical than in anthropogenic comments (Figure 1, $\chi^2_{(4)} = 9.16$, $p < 0.05$). The comments used the whole repertoire of nature of science found in the curriculum. For example: The temporary nature of scientific knowledge was expressed in claims such as: "In the seventies scientists claimed that the Ice Age would return". The counterargument claimed that: "*A small number of climate scientists in the 1970s indeed claimed that the Earth getting cold, but there was no consensus among scientists... One of the benefits of science is its ability to recognize and learn from mistakes. Computing capabilities have improved dramatically, allowing more accurate modeling of predictions"*. Comments which did not express any opinion had significantly less NOS content than those having clear opinions ($\chi^2_{(3)} = 42.48$, $p < 0.001$).

Statements about inquiry focused primarily on methodologies and ways of establishing proof, alongside scientists' predictions, in addition to raising questions, explaining, concluding and predicting. Skeptical comments expressed significantly more inquiry content than the anthropogenic comments ($\chi^2_4 = 14.62$, $P < 0.01$). Predictions were made on both sides: "*One degree in fifty years means that in a few hundred years we will not be able to live on the planet, sure" and* in contrast: *"So yes, the planet is getting warmer, but the assumption of cyclical periods of heat and cold says there will be another cooling, and there will be a long cold period just like the warming one"*.

The ethical discussion focused on conceptualization. The skeptical comments showed more (but non-significant) use of ethical concepts than the anthropogenic comments, but there was no difference between the counter positions with regard to the type of ethical statement. However, all clear positions showed significantly higher use of ethics than those with no clear opinion ($\chi^2_{(4)} = 28.9$ $p < 0.001$). There was a difference in the values stated in each position. The anthropogenic comments referred mainly to positive values or virtues such as truth and respect for the environment. A few negative values were mentioned such as depravity and incitement. The skeptical comments referred mostly to negative values such as economic corruption, and crimes against humanity. A few positive values were mentioned in the skeptical comments such as truth and saving the world.



Significance	Anthropogenic vs. skeptical	Opinion vs. no opinion
Concept index	**	**
NOS	**	**
Inquiry	**	**
Ethics	--	**

Figure 1. Scientific literacy in comments about climate change

Significance of the study

This study focused on an authentic, out-of-school environment in which participants express themselves based on their intrinsic motivation. 'Public Engagement with Science' provides a perspective to examine the use of scientific literacy by public engaging in the new media. The traditional *deficit model* of public understanding of science views public disagreement with scientists as a consequence of ignorance, that can be remediated with more information (Brossard & Lewenstein, 2010). However, our findings suggest that expressions of scientific literacy do not necessarily go hand-in-hand with the scientific consensus. Knowledge can be used to support different individual beliefs. According to Ho, Scheufele, & Corley (2010) policy choices are not associated with factual scientific knowledge but supported by trust in scientists and perceived risks and benefits. Nisbet and Scheufele (2009) maintained that personal value systems and beliefs filter or reinterpret information. Roberts, Reid, Schroeder, and Norris (2013) suggested that the development of positive attitudes might be achieved through a two-way dialogue.

One of the limitations of this study is responder anonymity. While responders can express themselves authentically, anonymity does not enable a more precise characterization of the research population. Reader comments are not representative of general public opinion. Therefore, this study can only describe the range of views and perspectives in public discourse online. Furthermore, the content analysis referred to the quantity of expressions of scientific and ethical expressions, but did not evaluate their quality. It is possible, therefore, that the use of science concepts or references to inquiry made in some of the reader comments was completely erroneous.

Notwithstanding these limitations, the environment investigated here is an authentic example of lifelong learning and the application of science literacy to everyday lives of non-technical public. Such environments need to be further considered in research and in curriculum design. Accordingly, we suggest emphasizing broad aspects of scientific literacy dealing with ethics, beyond scientific knowledge.

References

Bowen, G. M., & Rodger, V. (2008). Debating global warming in media discussion forums: Strategies enacted by persistent deniers. *Canadian Journal of Environmental Education*, 13(1), 89-106.

Brossard, D., & Lewenstein, B. V. (2010). A critical appraisal of models of public understanding of science. In L. Kahlor & P. Stout (Eds.), *Communicating Science: New Agendas in Communication* (pp. 11-39). New York: Routledge.

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B. r., Painting, R., . . . Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*(2).

Feinstein, N. W. (2011). Salvaging science literacy. *Science Education, 95*(1), 168-185.

Goldshmidt, R. (2006). The role of "TalkBacks" in the public discours in Israel. Jerusalem, Israel: The Knesset Information and Research Center (Hebrew) Retrieved from http://www.knesset.gov.il/mmm/data/pdf/m01546.pdf.

Ho, S. S., Scheufele, D. A., & Corley, E. A. (2010). Making sense of policy choices: understanding the roles of value predispositions, mass media, and cognitive processing in public attitudes toward nanotechnology. *Journal of Nanoparticle Research, 12*(8), 2703-2715.

Israeli Ministry of Education. (2010a). Biology high school curriculum. Retrieved from http://cms.education.gov.il/NR/rdonlyres/49543CBF-7737-4D88-98A4-47F73EE129E7/124019/mavo.pdf (in Hebrew).

Israeli Ministry of Education. (2010b). High school physics curriculum.

Israeli Ministry of Education. (2011). Science and technology curriculum for junior high school. Retrieved from Http://cms.education.gov.il/educationcms/units/tochniyot_limudim/science_tech.

Israeli Ministry of Education. (2012a). High school biotechnology curriculum.

Israeli Ministry of Education. (2012b). High school chemistry curriculum.

Israeli Ministry of Education. (2012c). High school curriculum in Environmental Sciences.

Israeli Ministry of Education. (2012d). High school science and technology in society curriculum.

Israeli Ministry of Education. (2013a). Elementary school science and technology curriculum.

Israeli Ministry of Education. (2013b). High school agriculture curriculum.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Howe, P. (2013). Climate change in the American mind: Americans' global warming beliefs and attitudes in April, 2013. Yale University and George Mason University. New Haven. 5.

Nisbet, M. C., & Scheufele, D. A. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany*, *96*(10), 1767-1778.

Pelham, B. (2009). Awareness, Opinions About Global Warming Vary Worldwide. Gallup. Retrieved from http://www.gallup.com/poll/117772/awareness-opinions-global-warming-vary-worldwide.aspx

Roberts, M. R., Reid, G., Schroeder, M., & Norris, S. P. (2013). Causal or spurious? The relationship of knowledge and attitudes to trust in science and technology. *Public Understanding of Science, 22*(5), 624-641.

Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education, 36*, 1-44.

Schicktanz, S., Schweda, M., & Wynne, B. (2012). The ethics of 'public understanding of ethics' – why and how bioethics expertise should include public and patients' voices. *Medicine, health care and philosophy, 15*(2), 129-139.

TIM. (2013). Internet Site Ranking. from TNS Teleseker Internet Monitor.