April 2019

Addressing the Climate Change Consensus Gap Among Preservice Teachers: A Four-Faceted Approach

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Session Title Science Teaching and Learning SIG Paper Session: Preservice Teachers

Session Type Paper

Presentation Date 4/8/2019

Presentation Location Toronto, Canada

Descriptors Environmental Education, Science Education

Methodology Mixed Method

Unit SIG-Science Teaching and Learning

DOI 10.302/1438921

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Abstract
In this paper, we report an estimate of the magnitude of the "consensus gap" – the gap between what scientists know about climate change and what the general public thinks they know – about anthropomorphic climate change among K-8 pre-service teachers. We also report qualitative findings about the utility of a four-faceted approach to teaching about climate change designed explicitly to mitigate inductive reasoning errors and to reduce in-group favoritism, attribution bias, inter-group conflict, and confirmation bias. We found that learning about the scientific consensus spurred student exploration about climate change. In particular, the careful use of deliberation toward commonly-held positions within a caring learning community rather than the more common 'debate' style of discussion fostered deep reflection.

1. Purposes

In this paper, we report an estimate of the magnitude of the "consensus gap" – the gap between what scientists know about climate change and what the general public thinks they know – about anthropomorphic climate change among K-8 pre-service teachers. To our knowledge, estimates of the consensus gap among pre-service teachers have not been previously reported. We also report qualitative findings about the utility of a four-faceted approach to teaching about climate change that we developed specifically to help students explore fraught topics (Author 1, 2017; Author 2, 2016; Authors, 2018). This multimodal study, which relates directly to the *"Leveraging Education Research in a 'Post-Truth' Era*" AERA theme, probes the following research questions: *(1) what is the magnitude of the consensus gap among pre-service teacher candidates* and *(2) what happens when we support exploration about the scientific consensus using our four-faceted approach?*

2. Perspectives

It is well established that climate change beliefs correlate more strongly with one's political affiliations rather that other factors that at first glance would appear more predictive, such as one's level of education or knowledge (see, for example, McCright and Dunlap, 2011; Stenhouse et al, 2014; Tranter & Booth, 2015; Whitmarsh, 2011). Oreskes and Conway (2010) make a convincing case that the partisan nature of climate change stems from purposeful, well-organized misinformation campaigns that seek to influence policy by sowing doubt in the public. These campaigns are discouragingly successful, and educators have been slow to respond, often assuming – incorrectly – that merely presenting learners with the scientific evidence of anthropomorphic climate change will be enough to sway opinion (Sterman, 2011). Unfortunately, this has proven staggeringly ineffective (Moser, 2010).

What is needed is climate change education that reaches not just the uninformed but those who actively resist scientifically established conclusions. Cook (2016) showed that "when people understand that climate scientists agree…, they are more likely to accept that global warming is happening, that humans are causing global warming, and that the impacts are serious, and, importantly, they are more likely to support policies to mitigate climate change" (para 17). Unfortunately, as many studies report, although about 97% of climate scientists believe in anthropogenic climate change, less than one in ten Americans correctly estimate the strength of that consensus (see Cook et al., 2016)

In this study, we used a four-faceted approach we developed to support dialogue about divisive topics to help teacher candidates learn about the scientific consensus about climate change and explore some of its evidentiary basis. For a full description of this approach, see Author 1, 2017; Author 2, 2016; Authors, 2018). In brief, the four facets include (1) *creating a strong classroom community explicitly to reduce in-group favoritism and attribution bias* (2) *identifying commonly held superordinate goals to reduce inter-group conflict* (3) *exploring content using deliberation toward a common goal rather than zero-sum debate to mitigate loss aversion and reduce confirmation bias,* and (4) *using real – or realistically imagined – people, places and events to help students think in concrete ways, which mitigates inductive reasoning errors.*

3. Modes of Inquiry

We initiated this multimodal study with a straightforward quantitative effort to gauge the magnitude of the consensus gap among teacher candidates in a large West Coast teacher preparation program. All second-semester candidates (N = 63) responded to the following prompt:

> Please provide a number between 0 and 100 that represents your estimation of the percentage of climate scientists who agree with the following statement:
>
> *"Earth's climate is changing, and human activity is the primary cause."*
>
> For example, if you estimate half of climate scientists agree with that statement, reply with "50%". If you think none agree, reply with "0%." If you think all agree, reply with "100%."

Responses to this prompt provided an estimate of the consensus gap.

With this estimate in mind, we began a qualitative inquiry exploring the efficacy of our four-faceted approach. Specifically, we probed the perceptions of a subset of these second-semester students (N = 26) about a week of climate science instruction centered on teaching about the scientific consensus and some of its evidentiary basis, as part of a required 16-week science methods course. We describe fully the pedagogical and content details of the week's instruction in the full paper; we relied heavily on Cook (2016) as a content planning guide.

Qualitative data analysis followed Creswell's (1998) guidelines for categorical aggregation, interpretation and generalization. Thus, during initial stages of data analysis, a relatively large number of codes was developed as we read the qualitative artifacts while simultaneously keeping information from the literature in mind, in what Miles and Huberman (1994) call "partway between the a priori and inductive approach" (p. 61). Codes were then aggregated into categories, and categories were organized into themes.

Once themes were identified, the data was re-examined with these themes in mind in order to make what Creswell (1998) calls "naturalistic generalizations."

4. Data sources

Quantitative data consisted of responses to the prompt described above (N = 63), as well as disaggregated demographic information about the cohort gathered from enrollment forms. Qualitative data consisted of student work from candidates enrolled in a science methods course (N = 26) where the four-facet approach was used, class observation notes, a teaching journal, and transcripts of semi-structured participant interviews.

Student work: student work centered on student understanding of and perceptions about the evidentiary basis underpinning the scientific consensus regarding climate change. This work consisted of text responses probing student understanding of a series of graphs (e.g. the Keeling curve, graphs from NOAA and the Department of Energy depicting medium and long term global temperature and atmospheric composition data, climate projections from the 2014 IPCC Synthesis Report (IPCC, 2014), and the like). Students also wrote responses to prompts asking them to justify their perceptions of the trustworthiness of the material and how it informed their own beliefs. Students then used these writings in deliberations with peers.

Class observations: Author 1 instructed the science methods course. Author 2 observed, seeking to capture details about exchanges that seemed related to student content understandings and misunderstandings as well as interactions related to climate change beliefs. Deliberations about the student work described above generated the bulk of these data. She used a two-column format to write observation notes, the left-hand column for low-inference descriptions and the right-hand column for in-the-moment subjective interpretations.

Instructor teaching journal: Author 1 kept a detailed teaching journal using a similar two-column format, writing from memory immediately after instruction.

Semi-structured interviews: Seven students expressed interest in being interviewed after the semester ended, five whose beliefs aligned with the scientific consensus and two whose beliefs differed substantially. Interviews lasted roughly half an hour and were audio recorded. At their request, two of the students were interviewed together. Using a semi-structured interview protocol, we asked the following open-ended questions, following up with related questions based on participant responses: (1) *What are your general beliefs about climate change? (2) What factors besides science (e.g. news stories, opinions of friends or classmates, etc.) influence your beliefs about climate change?* (3) *How did the week's instruction influence your beliefs? (4) In what ways did the pedagogical approaches (i.e. the four-faceted approach) encourage or discourage your learning about climate change science?*

5. Results

Quantitative Results

Twenty-four of the 63 pre-service candidates (38%) estimated the consensus rather accurately as between 91 and 100%. This is consistent with studies reporting the consensus gap among in-service teachers (see Plutzer et al., 2016). Notably, this is substantially more accurate than the general public; in the U.S, less than 10% estimates the consensus correctly (Leiserowitz et al., 2015). Interestingly, candidate estimates were not distributed evenly, but rather were bimodal; 15 of 63 (24%) underestimating the consensus substantially as between 41 and 50%, indicating a belief among these respondents that climate scientists are evenly split in their beliefs about the existence and/or the primary cause of climate change. (See Figure 1).

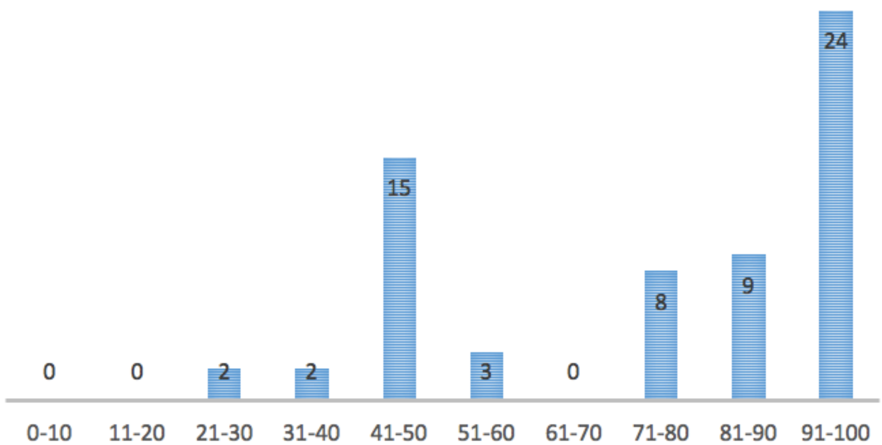

Figure 1: Candidates' estimates of the percentage of climate scientists who believe in anthropomorphic climate change. Deciles are presented along the x-axis; numbers of students are shown in each column. (N = 63)

Qualitative Results

Analysis of the qualitative data revealed two overarching themes related to our second inquiry question, which centered on the efficacy of our four-faceted approach (See sections 1 and 2).

Theme 1: Information about the scientific *consensus spurred students to investigate it further, but did not lead directly to changed beliefs.* Consistent with Cook (2016) our data suggests that learning about the strength of the scientific consensus strongly informed candidates' own beliefs. We note, however, that it was not by itself sufficient; instead, the information spurred many of them to (re)examine the origins of their own beliefs. As one student explained,

> *I had no idea the consensus was so strong! It really made me think about why I didn't know that. So I started Googling 'climate change' and finding stuff I thought was true and then paying attention to where the different information was coming from. So much of it sounds reasonable if you're not an expert. It's just another wake-up call. It's 2018. You gotta pay attention to where your info is coming from!"*

Theme 2: deliberation toward commonly-held positions within a caring learning community fostered deep reflection. Authentic dialogue has long been recognized as a powerful learning avenue (Burbules, 1993; Dewey, 2013; Freire, 2018; Rogoff, 1990). Of course, supporting dialogue about divisive topic is often difficult. Felton et al. (2009) show that when dialogue is framed as deliberation rather than debate, learners are more likely to consider the ideas of others. As they explain, deliberation asks students to map the landscape of commonality, while dispute is a zero-sum game with a winner and a loser. This difference loomed large in our data, and a caring community, as this exchange between two candidates illustrates.

> *[Student A]: It's so frustrating how people will believe such nonsense. Usually, that's a recipe for me to get dismissive. But the way we did in class kept interrupting that. Starting at some place of agreement and working out from there kept me focused on ideas instead of how to convince this idiot of anything! (jokingly, pointing at student B)*
>
> *[Student B]: Likewise. Usually I'd just dismiss this arrogant [expletive] (jokingly), but when it wasn't about convincing each other, it was about trying to find common ground… that let me stay in the conversation.*
>
> *[Interviewer]: So… you two disagree, but obviously you get along. Did you know each other before you started the program?*
>
> *[Student B]: Well, it turns out we agree on more than I thought, really. We just disagree on the magnitude and urgency. And no, we were strangers. But we talk a lot about 'maintaining a safe space' in class, and I think we really are at a place where we're judging ideas, not each other.*

Another student connected this pedagogical approach to the evolution of her thinking directly:

> *[Deliberation] let me think more about the facts and data and where it comes from. That stuff can kind of get lost so easily when you're trying to convince somebody, or if you feel like you're being attacked. I wasn't a [climate change] denier before or anything, but I was a lot more skeptical than I am now, and I don't think that [change] would've happened if it was just about arguing.*

6. Significance

This study's significance derives from the important role teachers play in climate change education. As Plutzer et al. (2016) report, around 70% of middle school science teachers teach climate change; discouragingly, however, more than 40% of those teachers incorrectly emphasize that climate change stems from natural causes. As discouraging as this is, it is not surprising given the magnitude of the consensus gap among practicing teachers. This study provides an estimate of the magnitude of that gap for pre-service teachers, information not previously reported. We also offer a useful way to reduce that gap by improving climate change education in teacher training programs.

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