Students' Plausibility Perceptions of Human-Induced Climate Change

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Abstract: Overcoming students' misconceptions may be a challenge when teaching about global climate change because students tend to confuse short-term weather effects with long-term climate transformations, which may stem from misunderstandings about deep time. Furthermore, student plausibility perceptions about human-induced climate change may influence understanding of scientific principles underlying the phenomenon. This study showed significant relationships between understandings of weather and climate distinctions, deep time, and plausibility perceptions of human-induced climate change after instruction.

Purpose of the Study

As students encounter global climate change in school and the media, they often approach the phenomenon with misconceptions. Research studies have revealed several of these misconceptions, including confusion about the distinctions between weather and climate (see for example, Papadimitriou, 2004). The purpose of this study was to examine how knowledge of these distinctions is associated with two additional and potentially related variables: plausibility and understanding of deep time. Plausibility is a critical construct in conceptual change (Dole & Sinatra, 1998). Change is more likely when students find the new conception to be highly credible. Appreciating deep time (or extremely long time periods), is essential to understanding several topics covered in science courses, including biological evolution, stellar life cycles, and global climate change. However, understanding deep time is difficult for students (see for example, Trend, 2001).

Theoretical Framework

Weather involves short duration atmospheric events at a particular location; whereas, climate is weather conditions averaged over long-term periods (at least a few decades) and wide areas (National Climatic Data Center, 2008). Weather and climate distinctions are not clear-cut, however. For example, one can discuss a severe weather outbreak over a wide region. Such ambiguities create challenges for students in understanding weather and climate distinctions, which have been the focus of a wide variety of research efforts (see for example, Papadimitriou, 2004).

Although the research community has thoroughly documented misconceptions about weather and climate distinctions, there has been much less research into how students can overcome these misconceptions. Students may experience cognitive conflict when exposed to scientific theories that are anomalous to their existing conceptions (Chinn & Brewer, 1993). For strong conceptual change, the new conception must be plausible (Dole & Sinatra, 1998). In the case of climate change, confusions about the distinction between weather and climate may contribute to views of human-induced climate change as implausible (Connell & Keane, 2006). Students' knowledge of how geophysical processes change over time may also affect their understanding of weather and climate distinctions; however, understanding deep time has proven difficult for students (see for example, Dodick & Orion, 2003).

Therefore, our purpose in conducting this study was to examine the variance in understanding of weather and climate distinctions explained by knowledge of deep time and perceptions of plausibility that humans are exacerbating changes to Earth's climate. We hypothesized that (1) knowledge of deep time would explain a significant amount of variance in student understanding of weather and climate distinctions above the variance accounted for by prior knowledge. We also hypothesized that (2) plausibility perceptions would provide explanatory power over and above that attributable to prior knowledge about these distinctions and knowledge of deep time.

Methods

Eighty-three undergraduate students from a university in the southwestern United States participated in the study. These participants were predominantly female (64%) and White (62%). Participants ranged in age from 18 to 66, and represented all undergraduate levels with 25% being Freshmen, 31% Sophomores, 29% Juniors, and 15% Seniors. We recruited participants from science courses in the university's geosciences department.

We used three questionnaires to examine: (1) knowledge of distinctions between weather and climate, (2) plausibility perceptions of human-induced climate change, and (3) understanding of deep time. Based on misconceptions research (see for example, Papadimitriou, 2004), we created a knowledge of weather and climate distinctions questionnaire (DWCM), where students classified 13 statements as related to either "weather" or "climate." We measured student understanding of deep time using the GeoTAT instrument, developed by Dodick and Orion (2003). The GeoTAT consists of six open-ended questions measuring "understanding of the temporal relationships among geological strata and their fossil contents" (p. 420). We also developed the plausibility perceptions measure (PPM), where students rated plausibility of eight statements about human-induced climate change culled from the latest report made by the United Nations' expert panel on global climate (Intergovernmental Panel on Climate Change, 2008). Participants completed the three questionnaires online through the university's course management system, and through this system, we made the questionnaires available to the students at the beginning and near the end of a semester's instruction. The participants first completed the DWCM, then the PPM, and finally the GeoTAT during both the pre and post instruction measurement periods.

Results and Discussion

To examine how well student understanding of deep time and plausibility perceptions of human-induced climate change explained understanding of distinctions between weather and time after instruction (DWCM post), we conducted a hierarchical multiple regression analysis. To account for background knowledge, we first entered DWCM pre, followed by GeoTAT post, and then PPM pre. Table 1 summarizes the results of our analysis, including means and standard deviations. For the full model, R^2 was significant, $F(3,79) = 10.90$, $p < .01$, indicating that about 29% of the variance in DWCM post was explained by the three independent variables. DWCM pre accounted for about 18% of the variance, with GeoTAT post accounting for an additional 6% of the variance above DWCM pre, and PPM pre accounting for an additional 5% above GeoTAT post. The results from the multiple regression analysis support both of our hypotheses that (1) understanding of deep time explains student knowledge of weather and climate distinctions after instruction above and beyond their prior knowledge about these distinctions and (2) plausibility perceptions of human-induced climate change add significant explanation above and beyond deep time understanding.

Table 1: Hierarchical regression predicting student understanding of weather and climate distinctions after instruction (DWCM post, $M = 9.30$, $SD = 1.94$).

	R^2	ΔR^2	ΔF	p	M	SD
Step 1: DWCM (Pre)	.183	.183	18.10	< .01	7.89	2.26
Step 2: GeoTAT (Post)	.242	.059	6.26	.014	12.75	4.33
Step 3: PPM (Pre)	.293	.051	5.69	.019	7.53	1.42

Note. The possible score range was 0 to 13 for the DWCM, 1 to 10 for the PPM, and 0 to 32 for the GeoTAT.

Conclusions

The results of this study reveal that greater knowledge of deep time and increased plausibility perceptions about human-induced climate change explain an increased of weather and climate distinctions, a common source of misconceptions related to global warming. To our knowledge, this is the first empirical study showing a significant relationship between plausibility and changes in knowledge, which in turn provides support to conceptual change theories where message plausibility is implicated as a key factor (Dole and Sinatra, 1998). Furthermore, this study shows that explicit instruction about climate change can ameliorate misconceptions about weather and climate distinctions. These significant relationships are a nascent research program's initial step toward deepening student understanding of climate change.

References

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