It Wasn’t Any Colder When I was a Kid: Heating up Instruction on Climate Change

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Overview

Heating up Science
Learning Research

Dole & Sinatra Conceptual Change Model

Heating up Climate Change Education Research
Heating up Science Learning

Once considered a cold and rational process...

Educational researchers now recognize role of “hot” constructs:

Emotion, motivation, social context... in science learning.

Hot constructs not just important, in some cases determinative of outcome.
What is Conceptual Change?

Conceptual Change is a special case of learning.

Occurs when individuals’ ideas conflict with new idea.

Requires overcoming existing ideas and changing current conceptions.

Learners have many incorrect notions about scientific concepts.
Conceptual Change research in the 80s-90s focused on:

1. Developmental changes in young learner’s conceptual knowledge
2. Cognitive factors: background knowledge, misconceptions
3. Design of instructional materials to foster change
Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change Pintrich, Marx, & Boyle (1993).

“. . .conceptual change is influenced by personal, motivational, social, and historical processes . . . [we advocate] a hot model of individual conceptual change” (p. 170).
Challenged the prevailing view of “conceptual ecology” (Posner, 1982).

“Ecosystems are not purposeful, but individual learners and communities of scholars can and do have goals, purposes, and intentions, thereby suggesting a role for an individual’s motivational beliefs” (p. 172).

Lead to the “next generation” of conceptual change models (Mason, 2006).
Cognitive Reconstruction of Knowledge Model, Dole & Sinatra, 1998

**Learner**
- **Existing Conception**
  - Strength
  - Coherence
  - Commitment
  - Motivation
  - Dissatisfaction?
  - Personal Relevance?
  - Social Context?
  - Need for Cognition?

**Message**
- Comprehensible?
- Coherent?
- Plausible?
- Rhetorically Compelling?

**Engagement Continuum**
- High
- Low

**If High**
- Strong Conceptual Change

**If Low**
- No Conceptual Change
- Peripheral Cue Present?
  - If Yes
  - If No

**Weak Conceptual Change**
Heating Up Climate Change Education Research

**Emotions**
- Broughton, Sinatra, & Pekrun (in progress)
- Lombardi & Sinatra (in progress)

**Epistemic Motivations**
- Sinatra, Kardash, Taasoobshirazi, Lombardi (in press)

**Plausibility**
- Lombardi & Sinatra (2010)
Emotions and Conceptual Change--Academic Achievement (Pekrun, 2002)

Positive activating can increase critical thinking.

Enjoyment, Hope

Negative deactivating can direct attention away from the task.

Boredom

Positive deactivating can temporarily reduce cognitive processing.

Relief

Negative activating can foster off-task thinking or may cause student to refocus efforts.

Anger, Frustration
Emotions and Conceptual Change

- activates critical thinking,
- directs attention,
- increases motivation,
- is likely to support conceptual change.

Emotions:

- superficial processes,
- redirects attention away from task,
- decreases motivation,
- is likely to prohibit conceptual change.
## Emotions about Climate Change

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Epistemic Motivations & Conceptual Change

Epistemic Motivations

- Motivations for engaging with knowledge as an object (Kruglanski, 1989)

Personality Characteristic

- Somewhat dispositional, relatively stable
- Open to change

Example: Need for closure

- Seek or avoid closure
Seeking and Avoiding Closure

Seeking for Closure
- Desire for a definitive answer
- Need to avoid ambiguity
- Can result in “freezing”
  - seizing on answer in decision making too quickly
  - less likely to show conceptual change

Avoiding Closure
- Need to seek info and question
- Comfort with complexity
- Willingness to tolerate ambiguity
- Necessary for conceptual change
Sinatra, Kardash, Taasoobshirazi, Lombardi (in press)

Would persuasive text promote:

• More accepting attitudes towards global climate change?
• Greater willingness to commit to take mitigative action against human-induced climate change?

Explore the relationship among:

• Dispositions
• Attitudes, and
• Commitment to action
Sinatra et al. (in press)
Research Method

College students read text on global warming edited from NY Times article on findings from Intergovernmental Panel Report on Climate Change

Measured epistemic motives, attitudes, & willingness to take action (drive smaller cars, change to efficient light blubs, etc.)
Demographics

140 UNLV UGs
85% Females
15% Males

Mostly Ed Majors
42% El Ed
17% Sec Ed
41% Other

Mostly Jr.
3% Freshman
17% Sophomore
60% Jr.
20% Sr.

Most politically interested
6% Not interested
20% A little interest
21% Somewhat Interested
37% Interested
16% Very Interested

Most Not Politically Active
37% < 1
15% @ 1
15% 1-2
11% @ 2
22% >2
Measures

1. Attitudes Towards Global Warming

Scientific evidence points to a warming trend in global climate.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly Agree</th>
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<tbody>
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<td>2</td>
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2. Commitment to Action

I’m willing to replace all the light bulbs in my house with energy efficient fluorescent bulbs.

<table>
<thead>
<tr>
<th>Not Willing at All</th>
<th>Somewhat Willing</th>
<th>Totally Willing</th>
<th>Willing Enough to convince others</th>
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### Measures

#### 4. Need for Cognition

I would prefer complex to simple problems.

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### Measures

#### 5. Need for Closure

I dislike unpredictable situations.

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<th>Strongly Disagree</th>
<th>Moderately Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Moderately Agree</th>
<th>Strongly Agree</th>
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Climate Change Debate: Doubt Gives Way to Certainty
NY Times, February 3, 2007
Shifts Pre to Post Reading

Attitudes towards Climate Change

Commitment to Take Action to Mitigate Climate Change

Read Text on Panel Report
Shifts Pre to Post Reading

- **Attitudes towards Climate Change**
  - Significant shift in Attitude
  - $F(1,138) = 206.0, p < .001, \eta^2 = .60$

- **Commitment to Take Action to Mitigate Climate Change**
  - Significant shift in Commitment to Action
  - $F(1,138) = 93.9, p < .001, \eta^2 = .41$
Commitment to Action: An Interesting Comparison

“I’m willing to pay more money to buy a hybrid car.”
Commitment to Action: An Interesting Comparison

“I’m willing to pay a 50 cent surcharge per gallon of gas to go toward greenhouse gas reduction.”

“I’m willing to pay more money to buy a hybrid car.”
Theoretical Model of Commitment to Take Action to Mitigate Climate Change

- Need for Cognition
- Close-Mindedness
- Pre-Attitude
- Pre-Commitment
- Post-Commitment
- Post-Attitude

Arrows and Correlation Coefficients:
- Need for Cognition to Pre-Attitude: 0.08
- Close-Mindedness to Pre-Commitment: -0.13
- Pre-Attitude to Pre-Commitment: 0.28
- Pre-Commitment to Post-Commitment: 0.74
- Post-Commitment to Post-Attitude: 0.30
- Pre-Commitment to Post-Attitude: 0.34
- Pre-Attitude to Post-Attitude: 0.86

Significance Levels:
- * p < 0.05
Lombardi & Sinatra (2010)
Research Method

Participants: Undergraduates enrolled in geoscience courses

- One course was on the science behind global warming.
- The other was a physical geography course, with a brief discussion of climate change.

Measured the following at semester’s beginning and end

- Plausibility perception of human-induced climate change
- Weather & climate distinctions
- Deep time understanding
When exposed to scientific claims about climate change...

...individuals may make mental representations of these claims...

...connect these mental representation to their background knowledge, and...

...Evaluate these connections as *plausibility judgments* (Chinn & Brewer 2001)
Connections to Background Knowledge (Connell & Keane, 2006)

\[ \text{implausibility} = \frac{\text{complexity}}{\text{corroboration} - \text{conjecture}} \]

Climate change involves many scientific principles = high complexity

Climate change evidence may have little connection to experience = low corroboration

Scientific statements of uncertainty = high perceived conjecture
Measuring Plausibility Perceptions

- 8 scientific statements from the report’s executive summary for policymakers
  - Scientific evidence supporting climate change (3)
  - Scientific evidence supporting a link in these changes to human activities (2)
  - Predicted impacts of future climate change (3)
- Minor modifications were made to minimize jargon
- Rated from 1 to 10
  - 1 = greatly implausible to 10 = highly plausible

IPCC Climate Change 2007
IPCC 2007 Statement Examples

Past Changes
- Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.

Human Activities
- Human influences on climate extend beyond average global temperature to other aspects, such as rising sea levels and widespread melting of snow and ice.

Potential Impacts
- Human caused global warming will lead to some impacts that are abrupt or irreversible, such as massive polar ice melt.
Plausibility & Conceptual Change (Chinn & Brewer, 1993; Dole & Sinatra, 1998)

A new conception must be **plausible** if students are to engage in greater cognitive processing and adopt this conception as their own.

An **implausible** conception may act as a barrier to conceptual change, where individuals may:

- Ignore/reject the data
- Incorporate data into their existing misconception
Some Climate Change Misconceptions

Evidence-related

Short-term and local weather events are evidence of global climate change

Cause-related

Stratospheric ozone depletion causes significant increases in global temperatures
Measuring Weather & Climate Distinctions

- There was a heat wave last summer.
- The average annual temperature in Reno is 51°F.
- The average temperature in Greenland was about 2°F greater between 1950 and 2000 than between 1900 and 1950.
- Strong and dry winds have contributed to an active fire season this summer.
- The number of glaciers in the Canadian Rockies has decreased over the last 100 years.
- Skies have been partly cloudy for the last three days.
Lesser deep time (aka geological or astronomical time) understanding may also contribute to misconceptions about the plausibility of human induced climate change.

Deep time understanding measured using the open-ended GeoTAT instrument (Dodick & Orion, 2003)
Understanding Weather & Climate Distinctions

Non-significant interaction, $p = .08$

Significant difference over time, $p < .001$

Non-significant difference between courses, $p = .6$
Non-significant differences between courses or over time, $p > .2$
Non-significant differences between courses or over time, $p > .09$
Model of Knowledge Change (Lombardi & Sinatra, 2010)

Knowledge of weather & climate distinctions (pre) predicted 18% of the variance, $p < .001$

Deep time understanding accounted for an additional 6% of the variance, $p = .01$

Plausibility perceptions accounted for an additional 5% of the variance, $p = .02$

$R^2 = .29, p < .001$
Lombardi & Sinatra (in progress)

Research Method

Participants: Pre-service elementary teachers and in-service science teachers engaged in climate change professional development

- Investigating the relationship among topic emotions, plausibility perceptions, knowledge of weather & climate distinctions, epistemic motives & disposition

Measured the following prior to instruction:

- Topic emotions
- Plausibility perception of human-induced climate change
- Weather & climate distinctions
- Needs for cognition & closure
What predicts teachers plausibility perceptions?  
*Model 1: Emotions about Climate Change*  
(Lombardi & Sinatra, in progress)

$$R^2 = .47, p < .001$$

- Ashamed about Climate Change: $\beta = .29, p < .05$
- Hopeless about Climate Change: $\beta = .41, p < .05$
What predicts teachers plausibility perceptions?

*Model 2: Emotions about Teaching about Climate Change* (Lombardi & Sinatra, in progress)

- Decisiveness
  - $\beta = -0.26, p < 0.05$

- Angry about Teaching
  - $\beta = -0.33, p < 0.05$

$R^2 = 0.32, p = 0.04$
Lombardi & Sinatra (2010, in progress)

Plausibility Perceptions

- Undegraduates
- Pre-service elementary teachers
- In-service science teachers

Scientific evidence supporting climate change
Evidence supporting human link
Predictions of future change and impacts
Millie (pseudonym)—a Caucasian physics and earth science teacher in her early forties—seemed extremely agitated by a recent mistake in a scientific report about climate change. Her reaction to the scientists’ apologies when the mistake was discovered was anger...

“Oh yeah, [scientists] lied about it... you just discredited yourselves! Well, now how am I supposed to believe you when you then come out with another statement...are you lying again? My question then becomes: what is your agenda?”
Implications

Teachers bring negative emotions to the classroom when teaching about climate change. Impacts teaching and learning.

To scientists, uncertainty is a quantitative judgment of known/unknown. To students, perceived as guessing; making climate change less plausible.

Explicit instruction of deep time, plausibility, and modeling uncertainty may ameliorate misconceptions.
Losing the Lake

Building a learning environment call Losing the Lake

Goal: teach users about effect of climate change on Lake Mead water levels

LTL simulations plus pedagogical resources (ref text, inquiry projects, argumentation schemes)

Outcomes: increase understanding of scientific modeling, knowledge of climate change, water conservation
Please select from the list or image the 3 most important changes you can do to conserve water:

- Fix leaky toilets
- Replace dishwasher
- Replace washing machine
- Cover swimming pool
- Remove lawns
- Do not wash car at home
- Plant trees
- Bathe instead of shower
- Replace windows
- Install low flow faucet aerators
- Replace showerheads
- Bathe or shower less often

See Results  Done
THANK YOU

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