Objective & Research Questions

Group Concept maps made by teacher participants were analyzed to characterize their understanding of the phenomenon of global climate change, adaptation and mitigation. The guiding research questions asked were:

- What is the cognitive structure of teachers' knowledge and understanding about the science of global climate change?
- How do teachers conceptualize Earth's climate system with respect to their knowledge of essential principles of climate literacy?

Cognitive Structure of Knowledge

Propositions were extracted from the concept maps and relational scoring method (McClure and Bell, 1990) was employed to score individual maps by evaluating each separate proposition identified on the map. Each construct employed to score individual maps by evaluating each relational scoring method (McClure and Bell, 1990) was Propositions were extracted from the concept maps and, consequently, examples and grouping were also evaluated (Novak and Gowin, 1984).

<table>
<thead>
<tr>
<th>Proposition Score</th>
<th>Proposition Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Misconception or incomplete information</td>
<td>Climate change -&gt;caused by -&gt;trapped photon</td>
</tr>
<tr>
<td>2</td>
<td>Structurally strong but not reflective of in-depth understanding</td>
<td>Albedo, reflected to-space</td>
</tr>
<tr>
<td>3</td>
<td>Structurally strong and shows in-depth understanding of a concept</td>
<td>Atmosphere contains more Energy -&gt; resulting in -&gt; increased storm intensity</td>
</tr>
</tbody>
</table>

- A lack of hierarchy, cross-links and extensive use of examples indicated the lack of integration of knowledge among climate concepts.
- An elementary understanding of the sources and impacts of global warming exists, but cohesiveness among different mechanisms of global climate change is lacking.
- Gaps in knowledge exist about “earth as a radiating body”, “long wave and short wave radiation”, “weather and climate” and “the Albedo” affect.
- Misconceptions about ozone layer causing climate change and the distinction between greenhouse gases and other emissions, were prevalent.

Professional Development Model

**Summer 2011 Institute**
Location: Cedar Creek Ecosystem Reserve Activities:
- Lectures from expert climate change researchers
- Biome exploration and characterization
- Tree ring data collection and analysis
- Training in GLOBE weather data collection protocols

**Fall 2011 and Spring 2012 Workshops**
Location: Bendix Middle School, Itasca Biological Field Station, LaCCore Center Activities:
- Wild rice harvesting
- Exploration of climate data and curriculum resources
- Lake coring and palaeoecology

**Summer 2012 Institute**
Location: Itasca Biological Field Station Activities:
- Expert lectures on exploring past climate through lake ecology
- Collection of water samples from Lake Itasca
- Analysis of water samples in relation to past data collected at the same sight

Assessment of Climate Literacy

- Teachers emphasized climate literacy principles related to human impacts of climate change.
- They were able to categorize the implications of GCC into “sociological,” “biological,” and “geological” consequences.
- Though knowledge about the causes and implications of global climate change is prevalent, there is a lack of appreciation for feedback that occurs within the climate system, modeling, theoretical studies and data about climate change.
- The connection between the greenhouse effect and the hydrological cycle shows ambiguity.

These results suggest that future workshop content should address misconceptions about weather and climate, the distinction between greenhouse gases and other emissions, and cohesiveness among climate change concepts.

Qualitative Analysis

- Out of the 6 concept maps, 4 concept maps were recognized as “net” structures and 2 as “spoke” like structures (Kitchin and Hay, 2008). Groups with “net” structures have much more complex understanding about GCC than the groups with “spoke” structures.
- The concept maps with spoke like structure used simple associations, more examples and lacked cross to other levels in the concept map have not yet been established. The net structures represented established connections among different concepts as well as among different levels of concepts. The use of more examples and analogies was observed in the spoke like structures than the net like structures.
- The teachers have more knowledge about the “what to do” “mitigation” and end for climate change. Certain propositions like fast carbon/mineral cycles including C, P, N Earth Worms ->causes -> faster degradation than adaption allows, which showed analogous, mechanical as well as evidence based properties were recognized as being most structurally strong and indicators of a higher and in-depth understanding of the science of GCC. (Wanderson, 1990).

CONCEPTUALIZING IN-SERVICE SECONDARY SCHOOL SCIENCE TEACHERS’ KNOWLEDGE BASE FOR CLIMATE CHANGE CONTENT

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CYCLES is a NASA Innovations in Climate Education (NICE) grant funded project designed to improve understanding of climate change science among teachers of Native American students in Ojibwe communities in northern Minnesota. Twenty secondary teachers are participating in a three-year teacher professional development program to develop and implement culturally-relevant approaches to climate change education.