Student Conceptions of Global Warming and Climate Change

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Research Question

- The purpose of this study was to investigate students' conceptions of global warming and climate change, expanding on previous studies. The research question was:

What are students' conceptions of global warming and climate change?

Background

- Reviewed 14 international studies that investigated secondary (grades 7-12) students' knowledge about global warming and climate change

- Grouped findings from these studies into 21 categories and four themes:

  - Basic conceptions about global warming and climate change
  - Causes of global warming and climate change
  - Environmental impact of global warming and climate change
  - Resolutions

Background: Highlights

- No distinction among “sun’s rays” (ultraviolet, infrared) or terrestrial rays
- Do not consider CO_2 a greenhouse gas or is the only greenhouse gas, air pollution in general is a greenhouse gas
- Greenhouse gases form a layer in the atmosphere that “trap” all of the sun’s energy
- Greenhouse gases deplete the ozone layer allowing more solar energy to reach the Earth causing global warming
- No consequence in my life or cannot be changed by humans
- Do not understand regional variation in global warming or climate change
- Limit CO_2 emission, drive less, pollute less

See paper for citations and references

Theoretical/Methodological Frame

- A constructivist perspective guided this study
  - Meanings constructed are context-specific (Schwandt, 1994)
  - Written language and drawings represent and communicate meaning (Holstein & Gubrium, 1994; Kress, Jewitt, Ogborn & Tsatsarelis, 2001)
  - Signs and symbols represent the students' interests, motivation, and purpose (Kress et al., 2001)
  - Reflect the unique social, educational, and cultural experiences of the student (Patton, 2002)
- Study was descriptive in nature and reflected a cross-age survey (Driver, Leach, Millar, & Scott, 1996)
  - Collected qualitative data (i.e., student written and drawn responses)

Methods

- Purposeful sampling strategy
  - A 122 secondary students (grades 7, 8, 10, 11, and 12) from the Midwest; multiple school settings increased the heterogeneity.
- Assessment instrument
  - Four open-response items and one draw-and-explain item
  - Designed as an idea eliciting task (Osborne & Freyberg, 1985) and based on the draw and explain protocol (White & Gunstone, 1992).
  - Student responses were not scored as “right” or “wrong” but were analyzed for their content

Methods

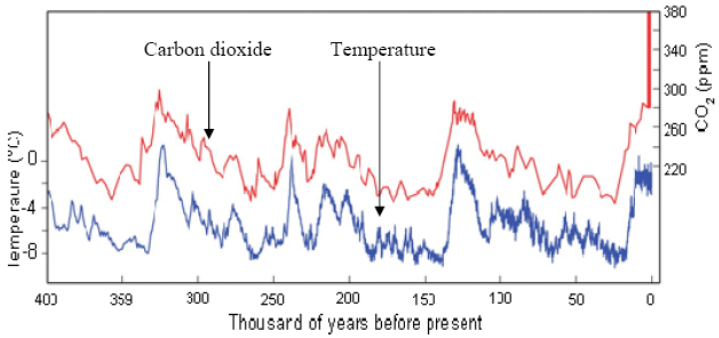
- The assessment instrument required students to:
  - interpret a scientific graph used as evidence for global warming (i.e., ice core data relating temperature and carbon dioxide).
  - explain what would happen to Earth's climate if carbon dioxide levels do not increase in the future.
  - explain how a warming climate might impact the oceans, weather, plants and animals, and people and society (Based on the NAEP grade 8 released item, "Some scientists think that the Earth's climate is getting warmer.")
  - draw and explain the greenhouse effect
  - describe how natural processes and human activities might cause carbon dioxide levels to change and what they could do to lower the level of carbon dioxide in the atmosphere

Methods

- Data analysis
  - Content analysis
  - Inductive in nature
  - Followed the analytical procedure described by Rubin and Rubin (1995):
    - First reading of the assessment, core concepts (codes) were identified. These initial codes were revised after a second reading.
    - codes with common/overlapping themes were grouped into categories
    - We constructed a category matrix that linked each code to a category (Erickson, 1986). This enabled us to organize and check the data for saturation and to eliminate redundancies (Erickson, 1986; Lincoln & Guba, 1985).
    - Independently constructing categories and reaching consensus provided a degree of triangulation, reducing the influence of bias and subjectivity and increasing the validity of our analysis and interpretation of the results (Patton, 2002; Strauss, 1987).
  - Data were analyzed for confirming and discrepant situations to enhance the authenticity of interpretations and credibility of findings (Patton, 2002)
  - An inter-rater reliability coefficient was calculated, 0.86, and coding was monitored to ensure consistency and reliability.

Results

- 75% graph supports that the Earth's atmosphere is warming
- 17% were not sure
- 7% such graphs help scientists understand which gases effect the Earth's climate
- 2% data did not support global warming and climate change



The top red line is carbon dioxide (CO_2)
The bottom blue line is temperature

Results: Global Warming

- 41% if there was no increase in atmospheric carbon dioxide levels there would be no further change in global warming or climate

- 55% climate would change regardless of atmospheric carbon dioxide levels—other atmospheric gases and air pollution in general would cause the climate to change

- 2% the Earth's natural tilt, rotation and orbit (natural processes) would cause the Earth's climate to change—seasonal variation

Results: Oceans

- 51% oceans warm and levels rise as a result of melting polar ice; 2% because of increased precipitation
- 14% oceans warm and levels decline because of increased evaporation
- 16% ocean evaporation would increase
- 10% more ocean precipitation
- None explained the potential impact on ocean life or coral reefs

Results: Weather

- 88% weather would get warmer and that would have an impact on precipitation, causing:
  - less snow (25%) and rain (12%)
  - more rain (27%)
  - more humidity (6%)
  - more evaporation (2%)
- None identified the potential impact on the frequency or severity of tornados and blizzards; yet, 12% thought there would be more hurricanes
- None explained the impact in terms of geographic location or regional variation

Results: Plants and Animals

- 94% global warming would impact plants and animals:
  - 76% plants and animals would die or decrease in number
  - 33% hotter weather would result in more plant and animal deaths
  - 6% warmer weather would benefit plants--longer growing season
  - 14% warmer weather would impact plant-animal interactions; a change in plants would have an impact on animals and vice-versa
  - 10% less rain would cause plant and animals to die/decline
- None described the impact on agriculture—crops and livestock. Focused only on “wild” animals and plants
- None explained any changes in geographic distribution

Results: Humans & Society

- 45% global warming will have no impact on humans or society. Human ingenuity and technology will solve the problem

- 25% global warming will cause human deaths; floods, heat, and lack of drinking water are the main causes of human deaths

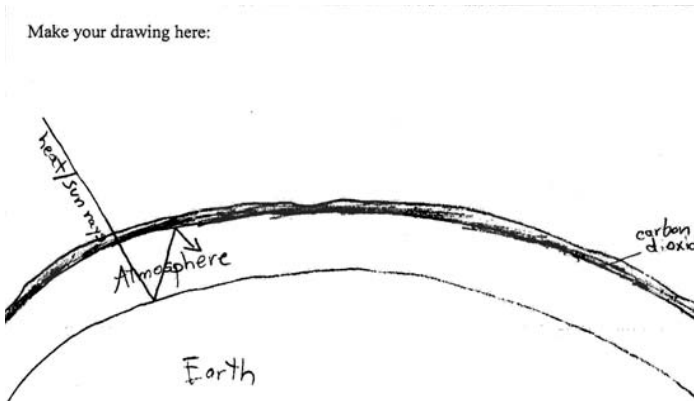
- Identified a number of human activities that cause atmospheric carbon dioxide levels to rise, they attributed the increase to vehicles (59%) and factories (49%)

Results: Greenhouse Effect

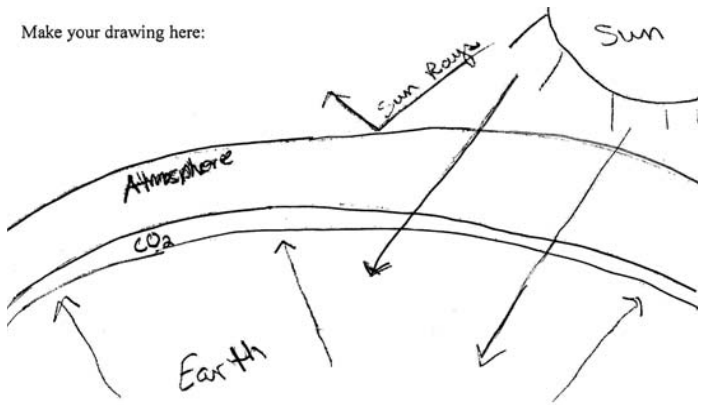
- 25% identified carbon dioxide as a greenhouse gas
- 25% drew and explained a “greenhouse”—literal representation
- 22% identified “greenhouse gases” in general
- 12% described “gases” in the atmosphere
- 10% identified air pollution in general
- 6% linked ozone depletion to the greenhouse effect

Results: Greenhouse Effect

- 24% represented carbon dioxide/greenhouse gas as a layer in the atmosphere

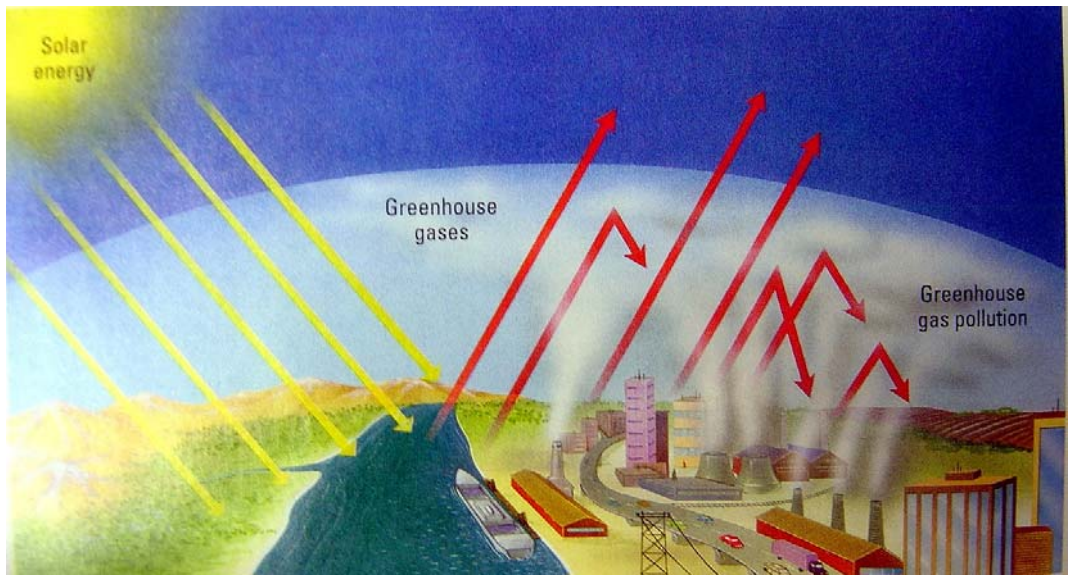


- 33% described the greenhouse effect in terms of the “sun’s rays” versus differentiating the radiative energy

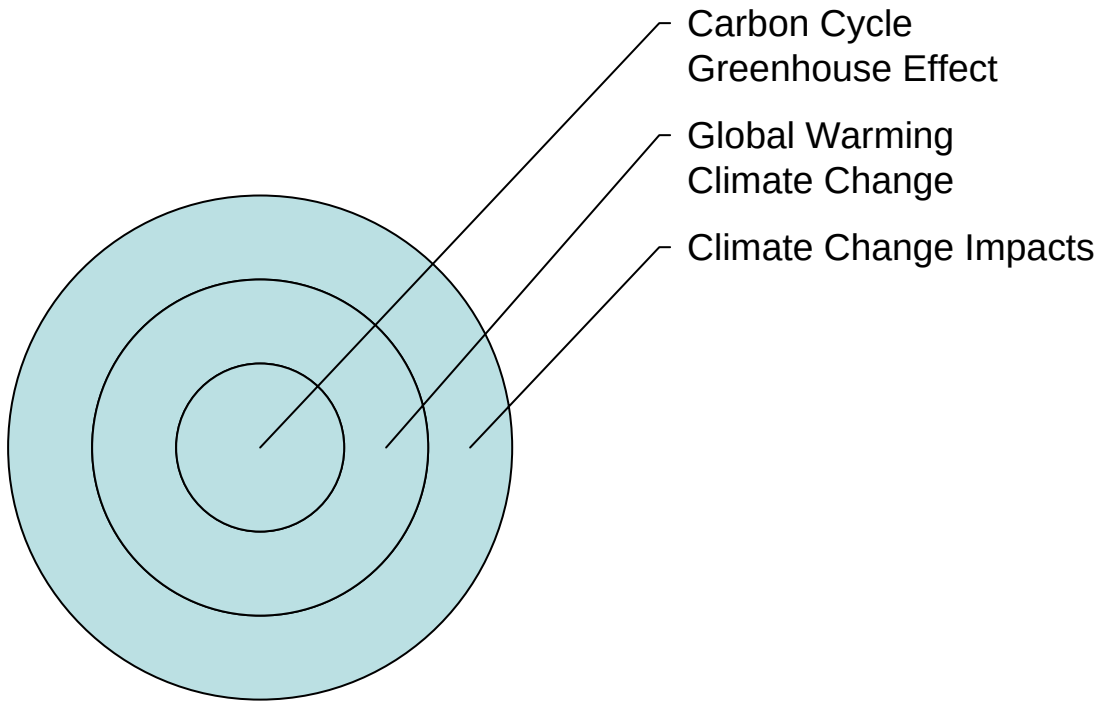


Results: Greenhouse Effect

- These conceptions of the greenhouse effect are re-enforced or even built on the diagrams used in many secondary earth and environmental science textbooks



Implications



Implications

- Carbon Cycle and the Greenhouse Effect
  - Carbon cycle and energy, the role of fossil fuels
  - Greenhouse effect, radiative forcing (infrared radiation, terrestrial radiation)
  - Earth's temperature balance
  - Greenhouse gases (e.g., water vapor, carbon dioxide, methane)
  - Human sources of greenhouse gases and personal solutions and actions (e.g. carbon footprint)

Implications

- Global Warming and Climate Change
  - Weather and climate
  - Time and space scales of different processes
  - Global warming, climate variability (e.g. El Nino and La Nina) and climate change
  - Earth’s tilt/orbit and relationship to Earth’s temperature and climate, seasonal and natural variations

Implications

- Climate Change Impacts
  - Impact on oceans, sea level rise, ocean life and weather
  - Severe weather events (e.g., tornados, thunderstorms, blizzards, hurricanes)
  - Water cycle changes, droughts/floods
  - Biomes, plant and animal distribution, migration, and plant-animal interactions
  - Societal and agricultural impacts