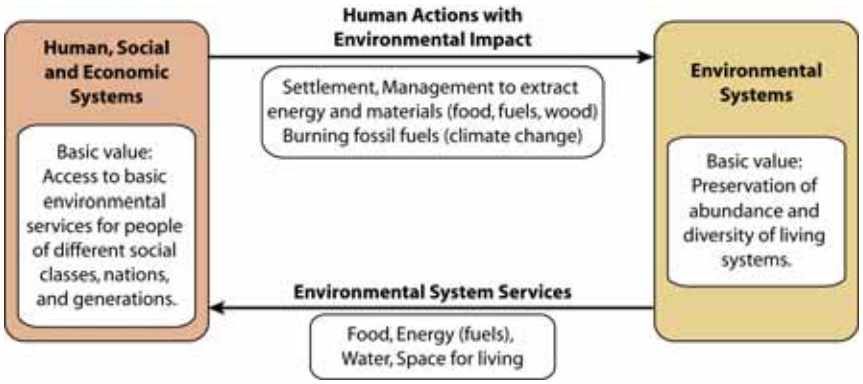
Can American Students Understand Global Climate Change?

By Charles W. Anderson, Lindsey Mohan, Kristin Gunckel, Blakely Tsurusaki, Beth Covitt, Christopher D. Wilson, and Hui Jin, Michigan State University

ENVIRONMENTAL LITERACY

Environmental Science Literacy

Humans are fundamentally altering the natural environmental systems that sustain all life on earth. Scientists are shifting the focus of their studies from natural ecosystems to *socio-ecological systems* for which human management and human dependence on environmental system services become a primary focus of study. Our work is focused on the question: *What scientific knowledge and practices should all students learn that will give them the capacity to be environmentally responsible citizens?*



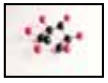
Both scientists and ordinary citizens need to understand the *socio-ecological loop,* and how our concerns about any part of the loop are connected with all the other parts.

Strands

We are studying how students make sense of four key aspects of the socio-ecological loop with the intent of developing assessments, standards, and teaching materials:

Biodiversity: the role of genetic diversity in populations and species diversity in farms, fields, forests, and other environmental systems.

Water: where our water comes from, where it goes, and the substances carried by water in environmental systems.



Carbon: how we produce and use carbon-containing compounds--foods and fuels--and how burning them affects our air and climate.

Citizenship: public and private decisions that affect the sustainability of environmental systems.

Trends from Younger to Older Students

- ***Awareness of Systems and Processes: From Invisible to Visible.*** Older students are aware of systems and processes that are invisible to younger students:
  - Microscopic, atomic-molecular, and large-scale systems
  - Gases such as carbon dioxide, oxygen, and water vapor
  - Invisible mechanisms such as photosynthesis, ground water flow, or genetic inheritance
- ***Precision in Measurement and Description: From Impressions to Data***. Older students learn to describe and measure in scientific terms and trust data rather than "seeing is believing."
  - Precise description and accurate measurement
  - Appropriate use of scientific terms categories
  - Using scientific tools such as tables and graphs for data representation and pattern finding
- ***Nature of Accounts: From Stories and Metaphors to Models Constrained by Principles***. Older students learn to explain and predict using scientific models rather than relying on stories and metaphors.
  - Using models to create stories rather than relying primarily on stories
  - Using principles (such as conservation of matter and energy) to constrain and connect models
  - Distinguishing theories or models from observations or data

Levels of Achievement

We use seven levels of achievement to map out students' progress in the trends described above

- ***Levels 1-3: Stories about events.*** Students make sense of the world by telling stories about events that they see and hear, with little awareness of systems or hidden mechanisms
- ***Level 4: School science narratives.*** Students include atoms, molecules, and large-scale systems in their stories, but they cannot use scientific models and principles to "complete the socio-ecological loop"
- ***Levels 5-7: Model-based reasoning about socio-ecological systems.*** Students use scientific models and principles to complete the loop, connecting human social and economic systems and issues with environmental systems and issues.

Implications

Very few American high school students do better than Level 4 when they try to explain basic processes in environmental systems, such as watersheds, invasive species, plant growth, combustion, and decay. This leaves them poorly prepared to see connections among the actions we take, the environmental system services we depend on, and our collective future.

Center for Curriculum Materials in Science (CCMS)

This research is supported in part by three grants from the National Science Foundation: Developing a research-based learning progression for the role of carbon in environmental systems (REC 0529636), the Center for Curriculum Materials in Science (ESI-0227557) and Long-term Ecological Research in Row-crop Agriculture (DEB 0423627. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Website:
http://edr1.educ.msu.edu/EnvironmentalLit/index.htm

EVIRONMENTAL LITERACY