

A Curriculum Approach Using Google Earth and Web-based Interactivities to Promote Climate Change Understandings

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Overview

1. Curriculum approach with geospatial learning
2. Highlight some climate change learning activities in the 21-day instructional sequence.
3. Implementation study results during the 2011-12 school year with 1,141 eighth grade urban students.

Environmental Literacy and Inquiry Group

<http://www.ei.lehigh.edu/eli>

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Farah Vallera– Data management

Middle school science teachers



Climate Change Misunderstandings of Secondary Students

- Greenhouse gas sources and their composition in the atmosphere
- Unaware of the role of water vapor as a key greenhouse gas
- How the greenhouse effect works
- Erroneous cause-effect relationship between the greenhouse effect, global warming, and ozone layer depletion
- Anthropogenic influences to the climate system

Curriculum Design Approach for Geospatial Learning

- Curriculum reform as change agent
- Instructional model for the development of inquiry learning activities with spatially-enabled learning technologies
- Educative materials to support teacher enactment –Content and Pedagogy
- Design principles
 - Data visualization use
 - Scaffolding
 - Accommodate the learning needs of diverse students

Support Materials

- Online reference content for teachers
- Teacher guides, assessment information, pedagogical implementation suggestions, visual guides

Climate Change Home
Overview
Instructional Framework
Instructional Sequence
Student Resources
Assessments
Instructional Resources
Support Materials

Paleoclimatology

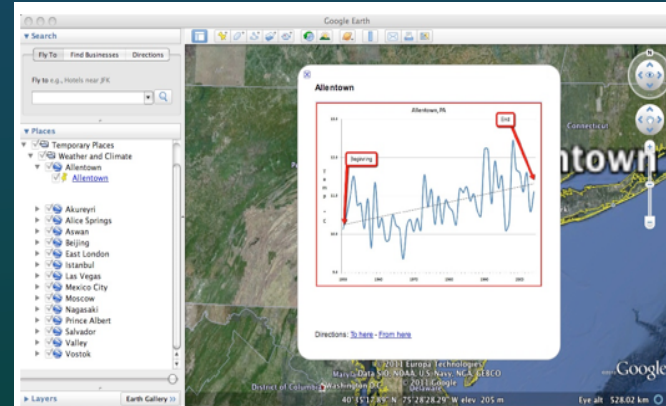
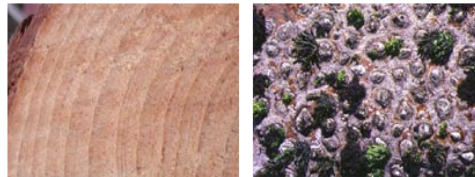
Climate Proxies

Scientists have been recording climate data for around 150 years. Therefore, when they need to estimate climate conditions from long before that in the geologic past, they study climate data that has been preserved in the environment. These environmental records are called climate proxies and can indicate to scientists the climatic conditions that occurred many millions of years ago.

Some climate proxies reveal general climatic patterns that occurred over the entire Earth such as the chemistry of fossil marine organisms or layers of sediment in the ocean that become sedimentary rock.



Some climate proxies are more helpful in understanding seasonal changes in specific regions such as tree rings and coralline red algae.



Distribute the **Weather and Climate Student Investigation Sheet** to each student. Tell students that they will complete the data table by analyzing climate graphs from 13 different global cities. For each city, they will record the minimum and maximum average annual temperature (in degrees Celsius) and determine the 50 – 58 year climate pattern.

The first row of the data table, Allentown, has been completed as an example. Have students view the Allentown climate graph in Google Earth to identify the minimum and maximum temperature. Remind the students that temperature is in degrees Celsius.

For Allentown, the minimum temperature is 9.4 °C (# 1 below) and the maximum temperature is 12.4 °C (# 2 below). The 50- 58 year climate pattern trends may be classified as < 0.5 °C, ~0.5 °C, ~1 °C, ~1.5 °C, or ~2 °C. Inform students that a magnitude of 1 °C is equal to a magnitude of 1.8 °F. Have students examine the linear trend line for Allentown. In Allentown, the temperature has increased about 1 °C in the last 58 years. Therefore, an "X" is placed in the ~1.0 °C column in the data table (see #3 below).

Weather and Climate Student Investigation Sheet

City	Latitude	Min Temp °C	Max Temp °C	Magnitude of Temperature Warming over the last 50 - 58 years (1950-2005)				
				< 0.5 °C	~ 0.5 °C	~ 1.0 °C	~ 1.5 °C	~ 2.0 °C
Allentown	40.588303 °N	9.4	12.4			X		
Akureyri	65.683868 °N							
Alice Springs	23.700339 °S							
Aswan	24.08 °N	# 1	# 2					
Beijing	39.904667 °N							
East London	32.991009 °S							
Istanbul	41.012379 °N							

<http://www.ei.lehigh.edu/eli/cc/support>

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Climate Change Home

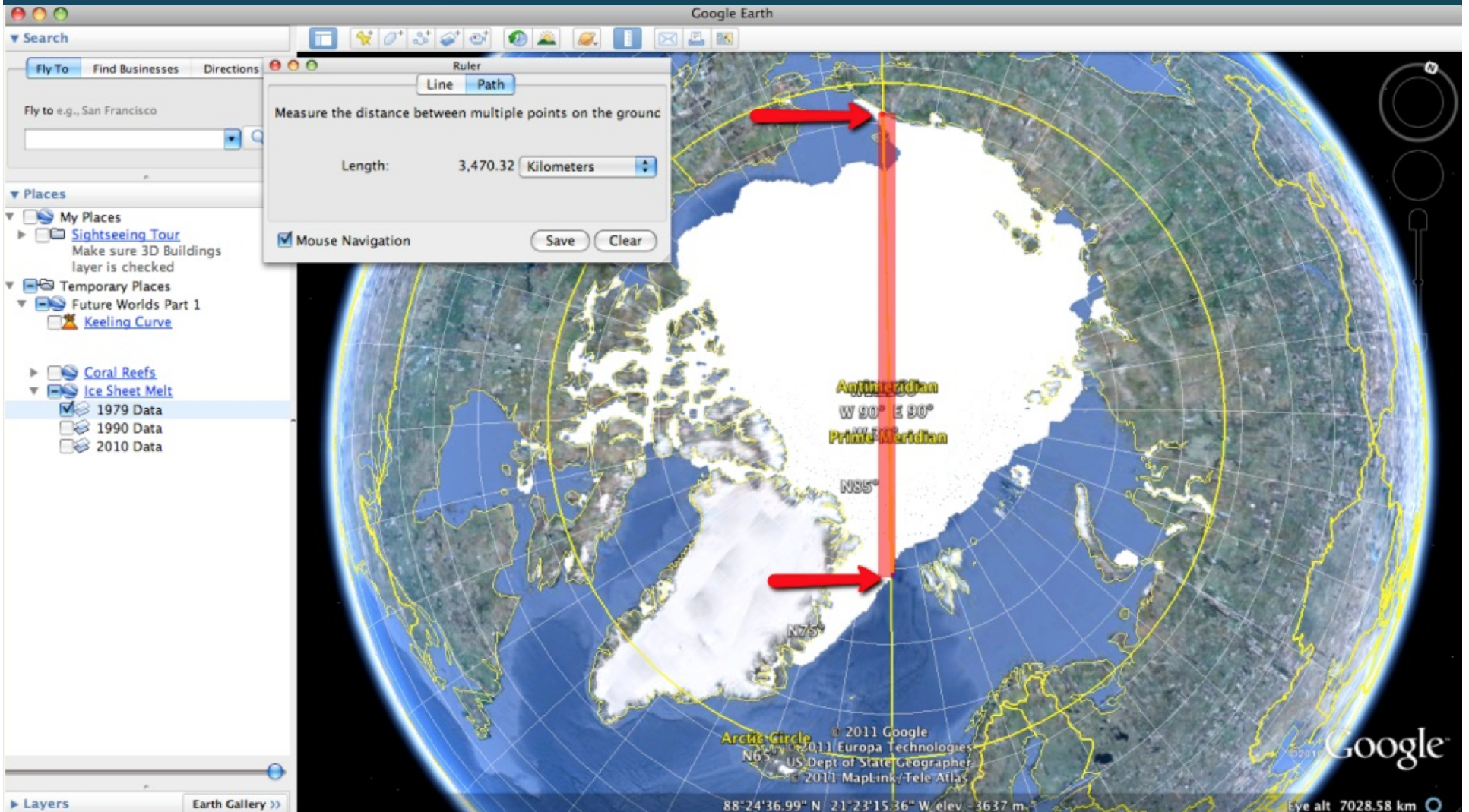
[Pretest](#)[The Atmosphere](#)[Earth System Energy Balance](#)[Weather](#)[Greenhouse Gases](#)[Paleoclimatology](#)[Climate and You](#)[Posttest](#)

Climate Change is a technology-supported middle school science inquiry curriculum. This curriculum focuses on essential climate literacy principles with an emphasis on weather and climate, Earth system energy balance, greenhouse gases, paleoclimatology, and how human activities influence climate change. Students use geospatial information technology tools (Google Earth), Web-based tools (including an interactive carbon calculator and geologic timeline), and inquiry-based lab activities to investigate important climate change topics. **Climate Change** is aligned to the *Essential Principles of Climate Literacy* in addition to national science and environmental education standards.

Climate Change has been pilot tested in urban middle school classrooms. Materials best used with the Firefox Web Browser and Google Earth version 5.2 or higher.

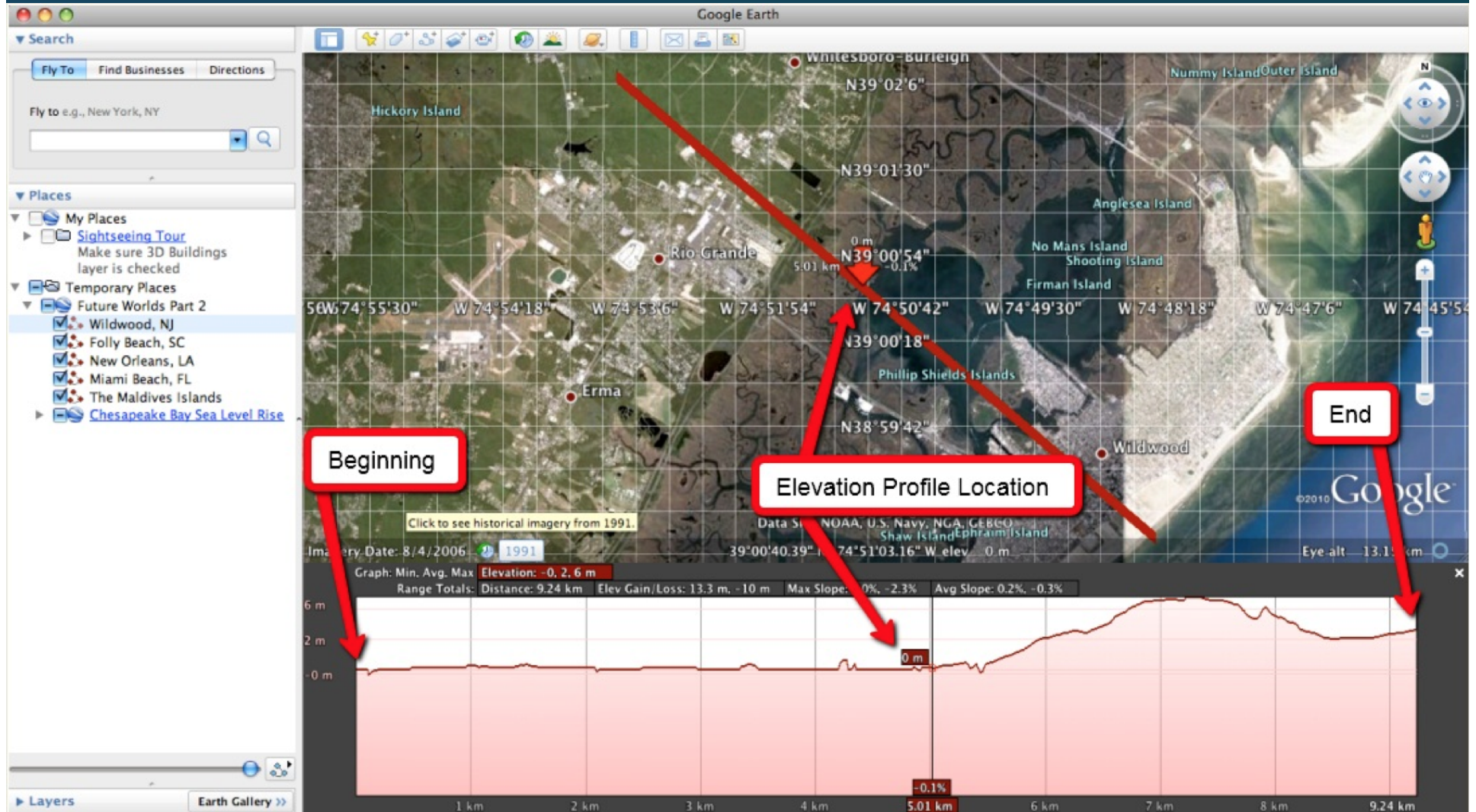
ELI is sponsored in part by the Lehigh Environmental Initiative. This material is based upon work supported by the Toyota USA Foundation.

Investigating Future Worlds with Google Earth




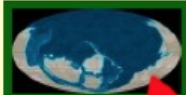
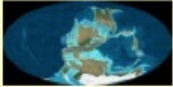
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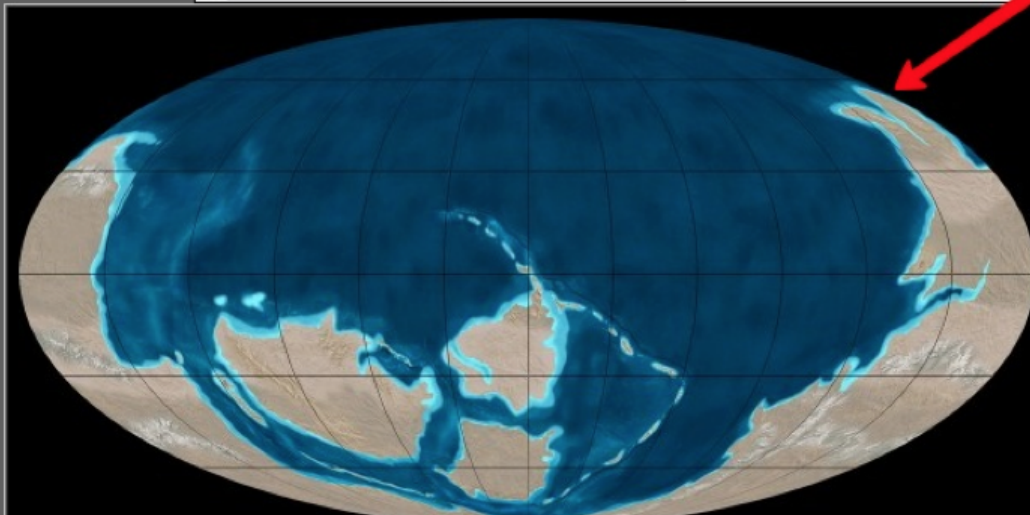
Investigating Future Worlds with Google Earth



<http://www.ei.lehigh.edu/eli/cc/sequence/day19.html>

Interactive Geologic Timeline

Period	Cryogenian	Ediacaran	Cambrian	Ordovician	Silurian	Devonian	Carboniferous
Exploration Image	 Click here to explore 715 ma		 Click here to explore 540ma		 Click here to explore 300ma		
Annual Global Temperature	~4 °C		22 °C		12 °C		
Annual Global CO2 Concentration	~100ppm		7000 ppm		350 ppm		
% Global Ice Cover	~85%		0%		20%		



540 Ma Cambrian Explosion

Rapid evolutionary processes at this time lead to the appearance of many new life forms. Evidence from the fossil record indicates that most major types of organisms appeared at this time. An ancient Atlantic Ocean, the Iapetus Ocean, was opening and beaches rimmed the North American continent.

<http://www.ei.lehigh.edu/eli/cc/sequence/day15.html>

Carbon Emissions Calculator

Carbon Emissions Calculator

Annual Carbon Emissions

1.76 tons

1597.54 kg

Annual Carbon Emissions From Household

1.76 tons

1597.54 kg

Household Transportation Food Analysis

1. How many people live in your home?

- ☐ 1
- ☐ 2
- ☒ 3
- ☐ 4
- ☐ 5
- ☐ 6 or more

+0.20 tons CO₂

Selecting a radial button automatically displays the amount of CO₂ that activity generates.

2. What type of home do you live in?

- ☐ An Apartment
- ☐ Townhouse/Row Home
- ☒ A house

+1.57 tons CO₂

3. Do you have Energy STAR appliances in your home?

- ☐ Yes
- ☐ No
- ☐ Not Sure

Implementation Study

- 1,141 eighth grade urban students; 11 teachers
- Climate Change Knowledge Assessment Measure
 - 28-item multiple-choice items (Cronbach's $\alpha = .86$)
3 open-response item (inter-rater reliability = .93)
 - Items aligned to misconceptions and knowledge deficits in the literature
 - Understandings of weather and climate differences
 - Atmospheric composition and the role greenhouse gases play in climate change
 - Essential features of the climate system
 - Anthropogenic source contribution to climate change paleoclimatology
 - Environmental impacts
 - Solutions to climate change
 - Teacher implementation surveys
 - Fidelity of implementation

Findings

- Post-test mean of the 28 multiple-choice items (16.91) were significantly higher than pretest mean (11.24)
 $t = 36.727, p < .001$
Large effect size: Cohen's $d = 1.27$
- Fidelity of implementation was high
 - Teachers frequently adhered to the entire instructional model
- High student engagement

Describe at least four different types of human activities that are causing the long-term increase of carbon dioxide levels over the last 100 years?

Category	Pretest	Posttest
Transportation - Driving cars	537	729
Using electricity / Energy consumption habits	239	458
Burning fossil fuels	189	453
Cutting down trees/ deforestation	158	239
Pollution from factories and industries	127	147
Industrial Farming	64	116
Use more heat in the winter and air conditioning in the summer	166	169

Describe at least four different things that you can do reduce or prevent further emissions of carbon dioxide into the atmosphere? Be specific.

Category	Pretest	Posttest
Change transportation habits	661	969
Reduce electricity use/ Reduce electrical consumption practices	377	818
Recycling practices / Reuse things	270	195
Change personal use of household heating and cooling	260	321
Grow trees, plants on your property / Don't cut down trees /Grow produce at home in a garden	160	127
Use alternative energy/Use solar or wind energy	45	24

What would it actually take for all the people on our planet to lower the levels of carbon dioxide in the atmosphere?

List at least four ideas.

Category	Pretest	Posttest
Change transportation habits	413	629
Use renewable energy sources / Limiting fossil fuel energy use	154	287
Plant more trees / Stop deforestation / Stop cutting down trees	152	135
Reduce electricity use	143	274
Use less air conditioning in the summer and heat in the winter	98	121
Reduce energy use / Use less energy	57	154
Use more greener technologies in factories/ stop factories from polluting the air	23	48
Invent better fuel efficient cars	21	35
Other: Invent an efficient and clean energy producer; Make public transportation widely available; Invest in clean energy; Everyone using energy efficient appliances; Make inefficient cars taxed or even illegal	14	13

Discussion

- Results indicated that the Climate Change curriculum was effective with supporting student learning of important concepts.
- Teacher response surveys indicated that the educative materials supported them with new ways of teaching climate change science content with a technology-integrated curriculum.
- Some misconceptions still persist with students.
 - More explicit instruction may be needed.
 - Additional year(s) of teacher curriculum enactment may enhance results.

Abstract available at:
**[http://www.ei.lehigh.edu/eli/
research/pubs.html](http://www.ei.lehigh.edu/eli/research/pubs.html)**

Climate Change curriculum:
<http://www.ei.lehigh.edu/eli/cc>

To access assessments, use:

Login: eliteacher
Password: 87dja92