AGU 2011
ED21A-0568

The Effectiveness of a Geospatial Technologies-Integrated Curriculum to Promote Climate Literacy

David J. Anastasio,
Dept. of Earth and Environmental Sciences
Lehigh University, Bethlehem, PA 18015

Alec M. Bodzin,
Dept. of Education and Human Resources
Lehigh University, Bethlehem, PA 18015

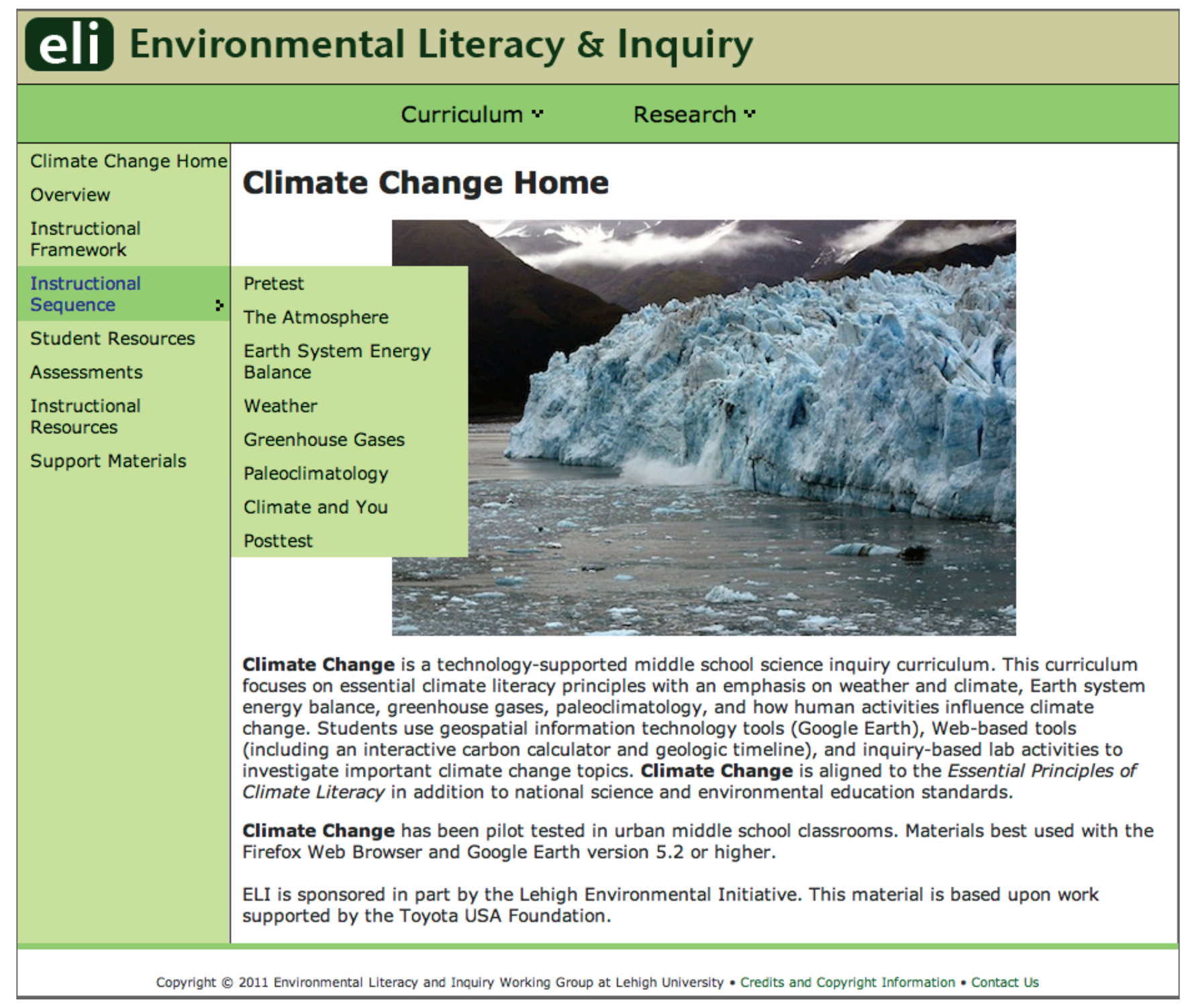
Tamara Peffer,
Dept. of Education and Human Resources
Lehigh University, Bethlehem, PA 18015

Dork Sahagian,
Dept. of Earth and Environmental Sci.
Lehigh University, Bethlehem, PA 18015

Lori Curucci
Broughal Middle School
Bethlehem Area School District
Bethlehem, PA, 18015

Overview and Instructional Sequence

The Climate Change Curriculum integrates geospatial inquiry based web and laboratory activities designed for a middle school learners. Assessments, teacher educative materials and rich teacher and student scaffoling provide a complete set of curricular materials for 21 days.



Environmental Literacy & Inquiry

Curriculum · Research

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

Instructional Sequence

The instructional sequence is a recommended instructional sequence. This sequence has been field-tested in 8th grade urban classrooms in three different tracked levels. We recognize that the ability levels of students will range significantly across different locations and some classrooms may complete activities faster or slower than what we have listed as the recommended time frame. We recognize that different teachers may feel the need to provide summative assessment quizzes or additional review activities at specific points during the instructional sequence. Such activities will vary across different teachers and classroom contexts.

We have not recommended specific homework assignments for each day in the instructional sequence. We recognize that the assignment of homework will vary significantly across each classroom based on the philosophy of teachers and school districts. We have noted suggested supplemental readings on specific days that can be assigned for homework. These are PDF documents that can be accessed by students on the Climate Change Student Resource page or reproduced and distributed as hard copies. The completion of student worksheets may also be assigned as homework. We also encourage teachers to assign journaling activities and concept mapping activities as homework to help students review the main unit concepts.

Student instructional handouts and teacher support materials are provided in both MS Word and PDF formats. **Student handouts can be modified to provide additional supports and step-by-step instructions by adding text passages from the teacher versions of select handouts.**

Click on the links below to access a detailed instructional sequence for each day that includes student resources (Google Earth files, videos, and images), instructional handouts, and teacher curriculum support materials.

Although this site is designed to be cross-platform, we recommend the use of the Mozilla Firefox Web browser.

Day 1 - **Pretest**. Introduction to Climate Change unit. Students will complete the climate change unit content knowledge pretest assessment.

Day 2 - **Investigating Weather and Climate with Google Earth**. Students will use Google Earth to explore global temperature changes. They will use Google Earth to determine how the temperature of the Earth has changed during a recent 50 - 58 year period. They will also explore, analyze, and interpret climate patterns of 13 different cities, and analyze differences between weather and climate patterns.

Day 3 - **Earth Systems and Atmosphere.** Students will be introduced to the four main Earth spheres (atmosphere, lithosphere, hydrosphere, and biosphere) and the structure and composition of the atmosphere. Students will also understand the different roles that ozone plays in the troposphere and the stratosphere.

Day 4 - **Atmospheric Gases.** Students will explore the variety and ratio of compounds and elements that make up the Earth's atmosphere. They will understand volumetric measurements of gases in the atmosphere and visually depict the composition of the atmosphere.

Day 5 - **Greenhouse Gases.** Students will be introduced to the major sources of greenhouse gases. Students will understand that greenhouse gases are produced by both natural and anthropogenic (man-made) sources.

Day 6 - **Investigating Albedo.** Students will be introduced to the effect of albedo on surface temperatures. Students will observe the change in surface temperature as dark and light surfaces are exposed to light energy. Students will understand how light reflection and absorption are related to albedo. Students will understand that lightly colored surfaces have higher albedo than darker colored surfaces.

Day 7 - **Planetary Energy Balance.** Students will understand that different Earth materials (water and sand) have different heat capacities. Students will learn about key processes involved with planetary energy balance including surface and atmospheric absorption and reflection.

Day 8 - **Planetary Energy Balance.** Students will understand how the angle of incoming solar radiation affects the climate of the Earth.

Day 9 - **Investigating Weather with Google Earth.** Students will use Google Earth to explore some factors that affect weather. They will use Google Earth to determine how latitude, elevation, proximity to bodies of water, and mountain ranges affect a location's climate. They will also explore, analyze, and interpret weather patterns in 7 different U.S. cities.

Day 10 - **Carbon Cycle.** Students will learn how carbon cycles between the Earth's spheres. They will understand that there are both natural and anthropogenic (man-made) sources of carbon that are emitted into the atmosphere. They will examine the Keeling Curve data to visualize how much carbon has been emitted into Earth's atmosphere during its recent past.

Day 11 - **Greenhouse Effect Lab.** Students will understand the importance of greenhouse gases in our atmosphere and that excess CO2 intensifies the greenhouse effect.

Day 12 - **Climate Proxies.** Students will be introduced to examples of paleoclimate proxies. They will analyze a tree ring proxy to understand that annual light and dark layers represent summer and winter tree growth. In addition, they will interpret a tree ring record to learn that the width and shape of the tree ring is dependent on environmental conditions.

Day 13 - **Paleoclimate Reconstruction Lab.** In this lab investigation, students will reconstruct past climates using lake varves as a proxy. They will explore the use of lake varves as climate proxy data to interpret long-term climate patterns and understand annual sediment deposition and how it relates to weather and climate patterns.

Day 14 - **Paleoclimate Reconstruction Lab.** In this lab investigation, students will reconstruct past climates using lake varves as a proxy. They will explore the use of lake varves as climate proxy data to interpret long-term climate patterns and understand annual sediment deposition and how it relates to weather and climate patterns.

Day 15 - **Interactive Geologic Timeline Activity.** In this learning activity, students will use a Web-based Geologic Timeline to understand how the climate has changed in the last 715 million years. They will examine temperature, CO2 concentration, and ice cover data to investigate how climate has changed during the last 715 million years; understand that long term climate patterns provide evidence for fluctuating CO2 concentrations; and record and analyze a long-term global climate data set.

Day 16 - **Carbon Calculator Activity:** In this learning activity, students will use a Web-based carbon calculator to determine their carbon footprint. Students will examine their personal and household habits and choices in relation to their carbon footprint; identify which personal activities and household choices produce the most CO2 emissions; and compare their carbon footprint to the U.S. and global averages and identify lifestyle changes they can make to reduce their footprint.

Day 17 - **Investigating Earth's Climate Hot Spots.** Students will use Google Earth to investigate areas affected by climate change.

Day 18 - **Investigating Future Worlds with Google Earth (Part 1).** Students will use Google Earth to explore evidence of climate change during 1980 - 2010. They will use Google Earth to explore changes in the extent of Arctic Sea ice over a recent 30-year period, explore changes in the distribution of coral reefs in the Caribbean Sea, and understand that climate change will continue to affect our planet into the future.

Day 19 - **Investigating Future Worlds with Google Earth (Part 2).** Students will use Google Earth to explore the effects of a 2 meter rise in sea level on the existing landscape. Students will use the Google Earth elevation profile tool to understand the effects of sea level rise in 5 low lying coastal areas and explore changes in sea level in the Chesapeake Bay region.

Day 20 - **Carbon Reduction Strategies.** Students will explore carbon reduction strategies at personal and societal levels. They will explore how sustainable energy resources and carbon capture and storage methods can help reduce carbon emissions levels.

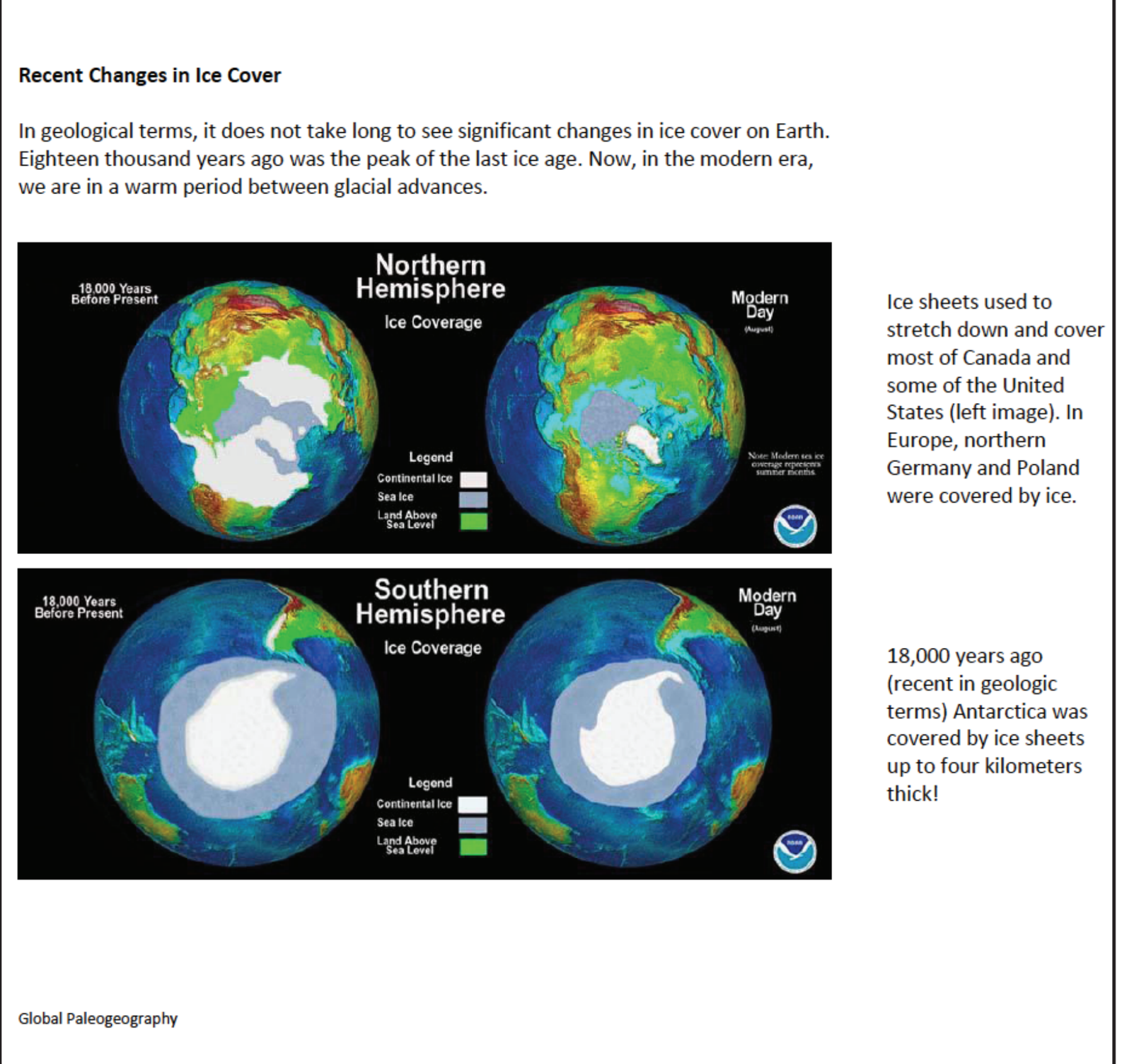
Day 21 - **Posttest.** Students will complete the climate change content knowledge posttest assessment.

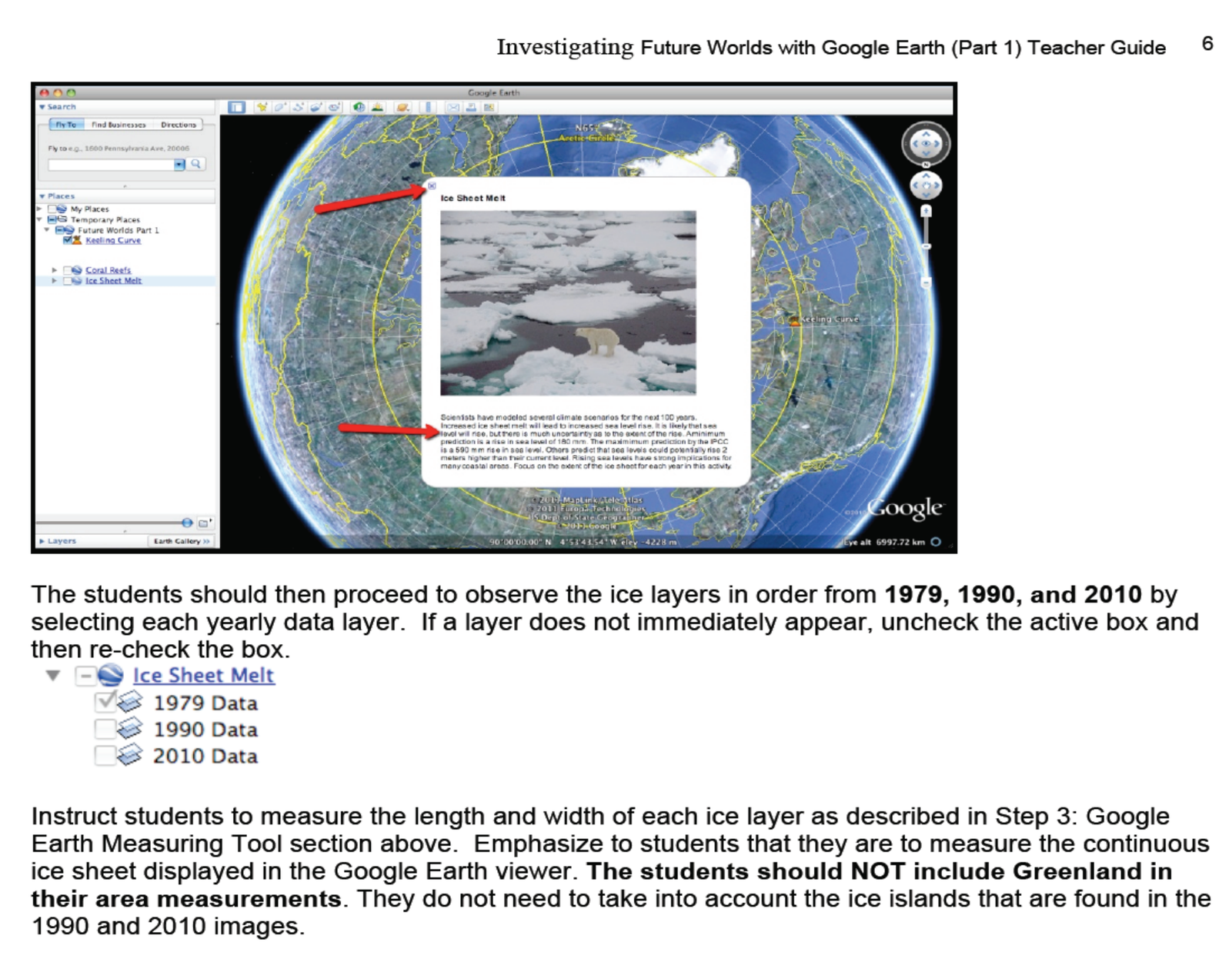
Support Materials and Examples

Online reference content for teachers
Google Earth kml Files
Instructor PowerPoint Files

Instructional Web GIS handouts:
Teacher Guide
Student Handout
Investigation Sheet
Assessment Information

Web GIS video tutorials





Acknowledgements:

Violet Kulo - Instructional Desigh
Denise Bressler - Science Education
Laura Turner - Instructional Design and Web Development
Matt Diltz - Computer Science and Web Interactivities

Funding:

TOYOTA USA FOUNDATION

Results

The pre- and post-test Climate Change Knowledge Assessment data were organized and sorted to include only those students who had completed both assessments. Correct responses were tallied for the items. Paired-sample t-test analyses were conducted to compare the pre- and post-test results. The results of these analyses were used to compare overall gains as well as ability level track groups. Overall results regarding the use of the Climate Change curriculum showed significant improvement in urban middle school students' understanding of climate change concepts. Effect sizes were large (ES>.8) and significant (p<.001) for the entire assessment and for each ability level subgroup.

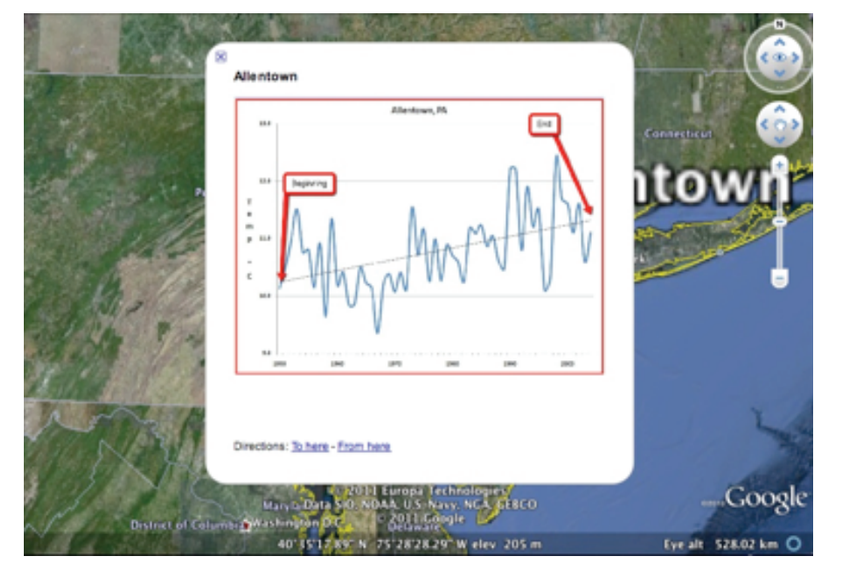
Overall Climate Change achievements by ability and track for Pre/Post Tect. N=109

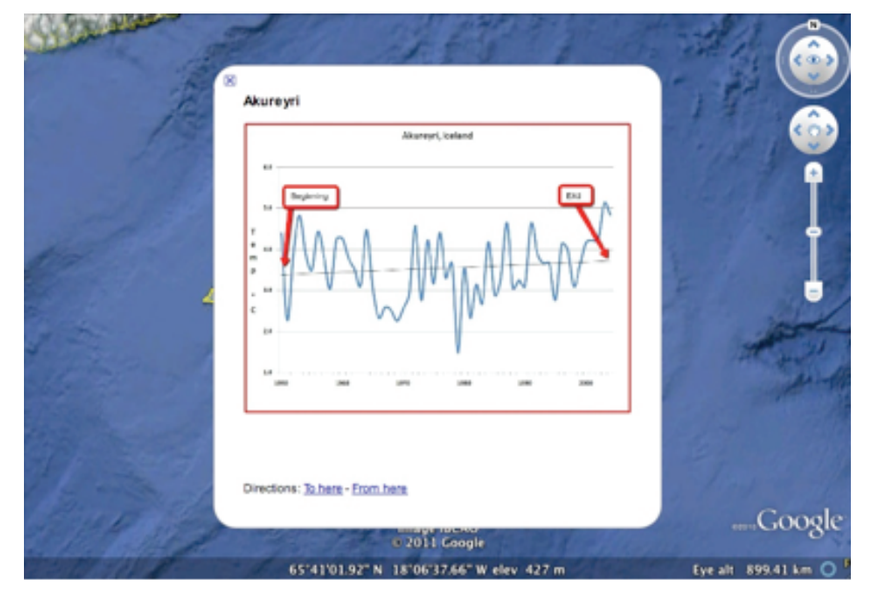
	Pretest Mean (SD)	Posttest Mean (SD)	t-Value	Effect Size
Overall (N=107)	8.91 (3.00)	12.17 (3.40)	10.676*	1.21
Low Track (N=34)	7.44 (2.38)	10.32 (2.87)	3.55*	1.20
Middle Track (N=44)	8.75 (2.65)	12.00 (2.90)	7.05*	1.23
Upper Track (N=29)	10.86 (3.17)	14.59 (3.32)	7.031*	1.17

*p<0.001

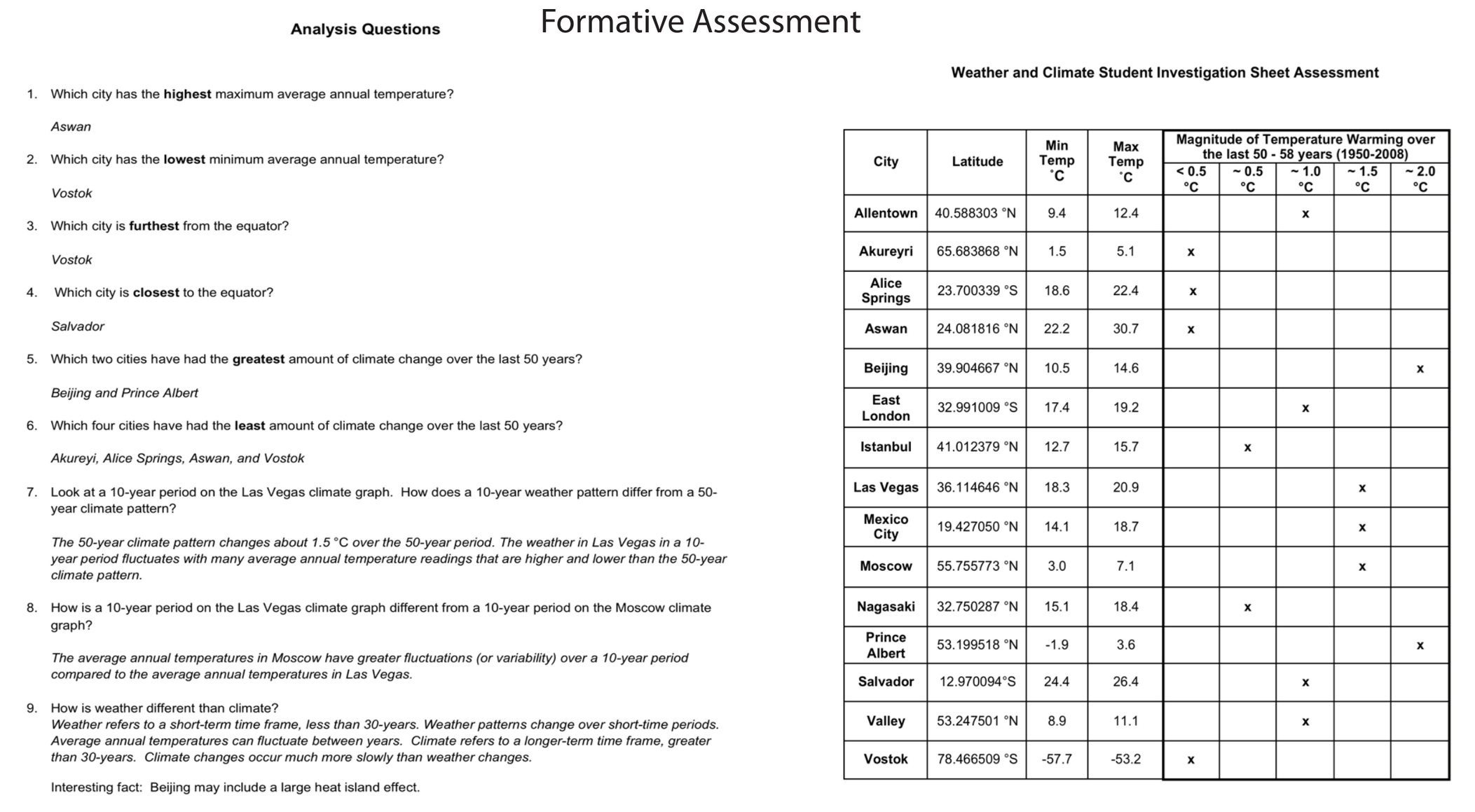
Example Activities

Day 2 - Investigating Weather and Climate with Google Earth. Students will use Google Earth to explore global temperature changes. They will use Google Earth to determine how the temperature of the Earth has changed during a recent 50 - 58 year period. They will also explore, analyze, and interpret climate patterns of 13 different cities, and analyze differences between weather and climate patterns.



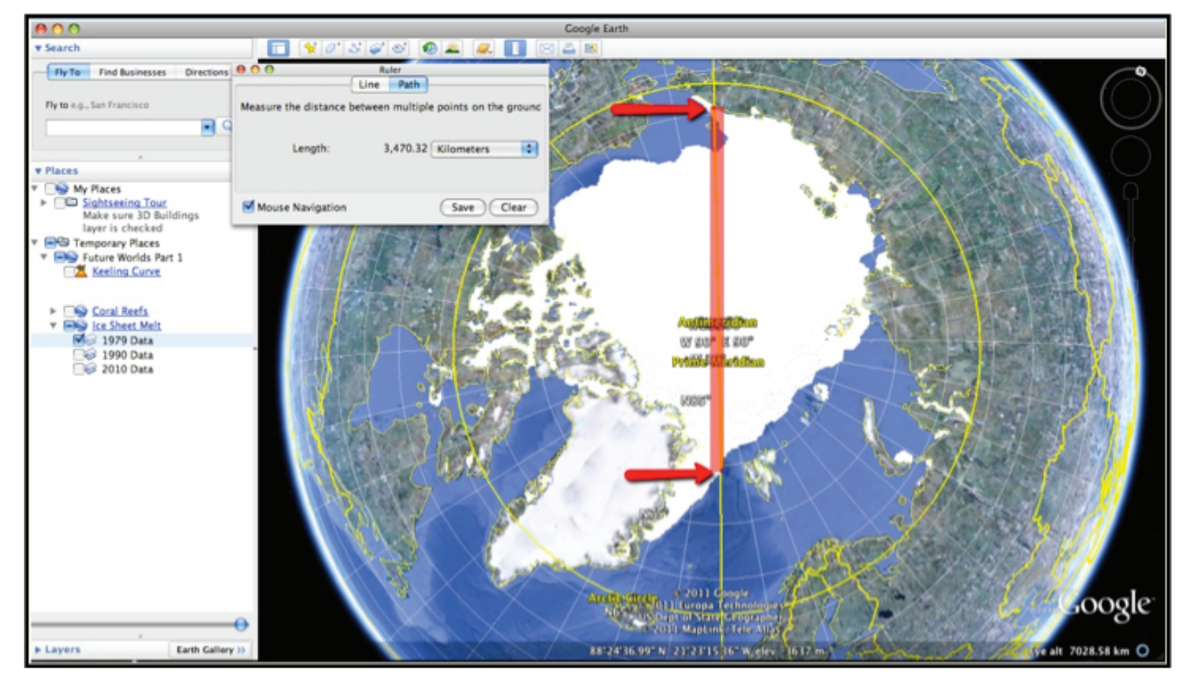


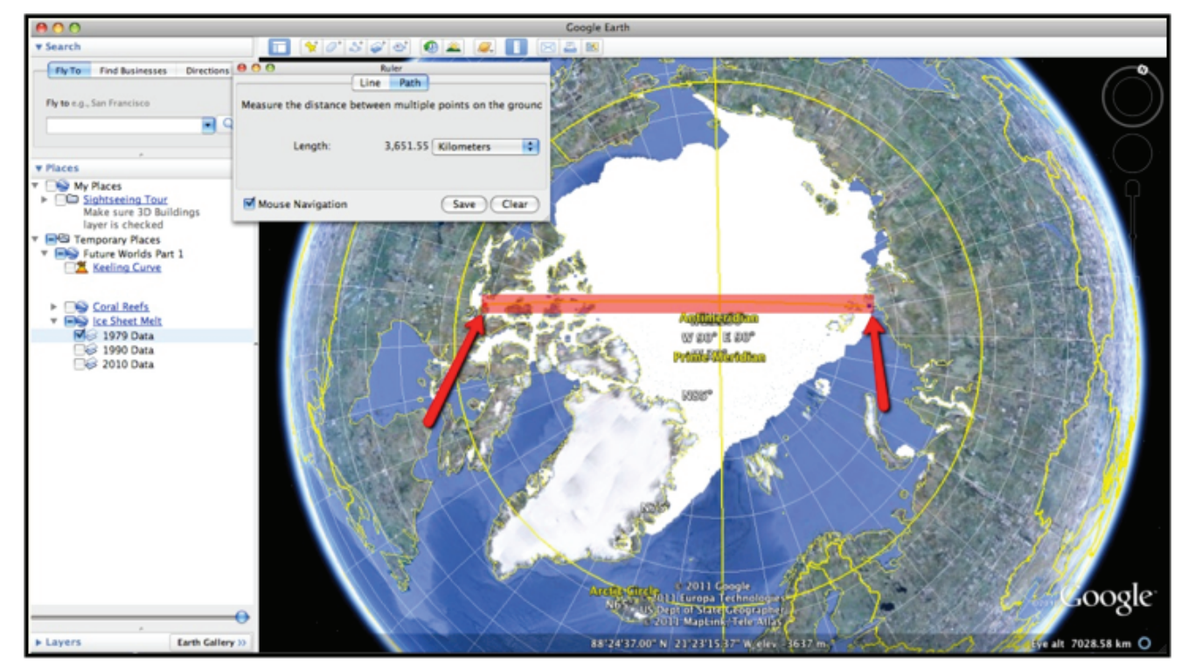
Formative Assessment

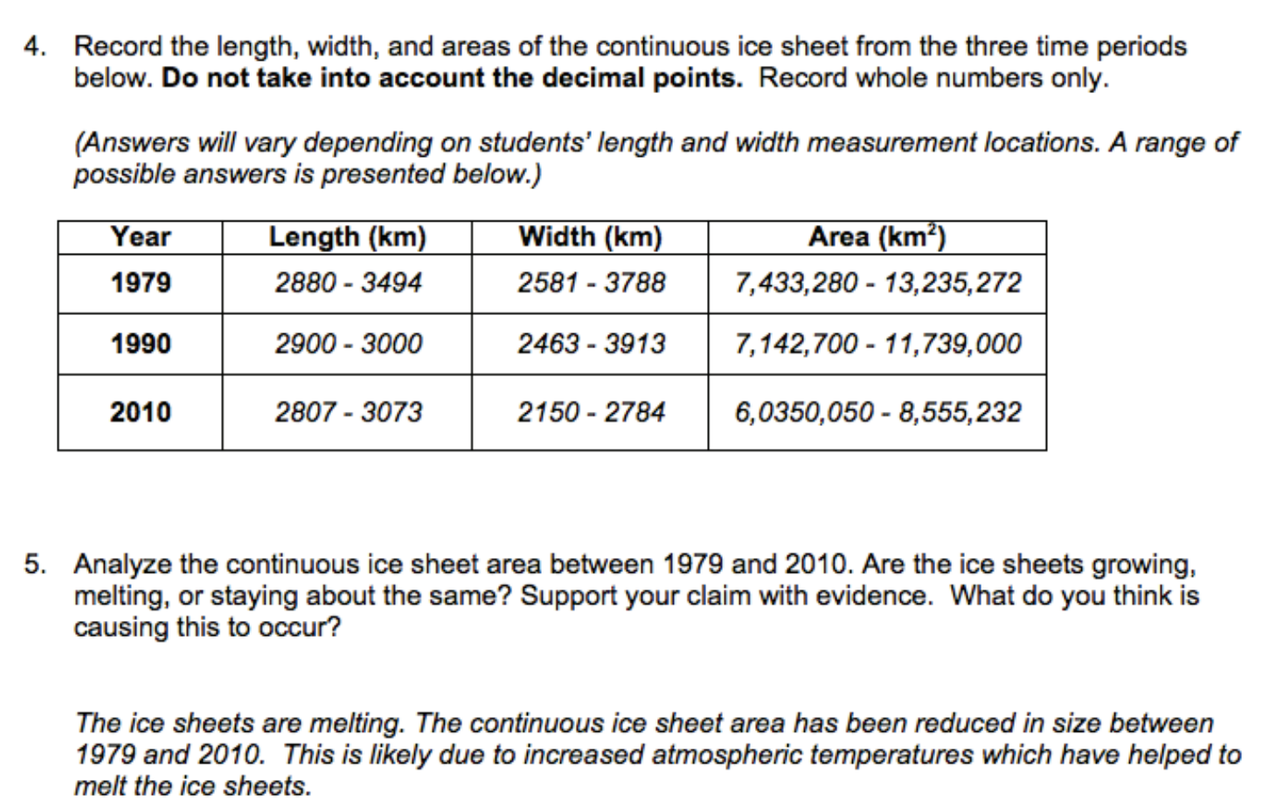


Day 18 - Investigating Future Worlds with Google Earth (Part 1). Students will use Google Earth to explore evidence of climate change during 1980 - 2010. They will use Google Earth to explore changes in the extent of Arctic Sea ice over a recent 30-year period, explore changes in the distribution of coral reefs in the Caribbean Sea, and understand that climate change will continue to affect our planet into the future.

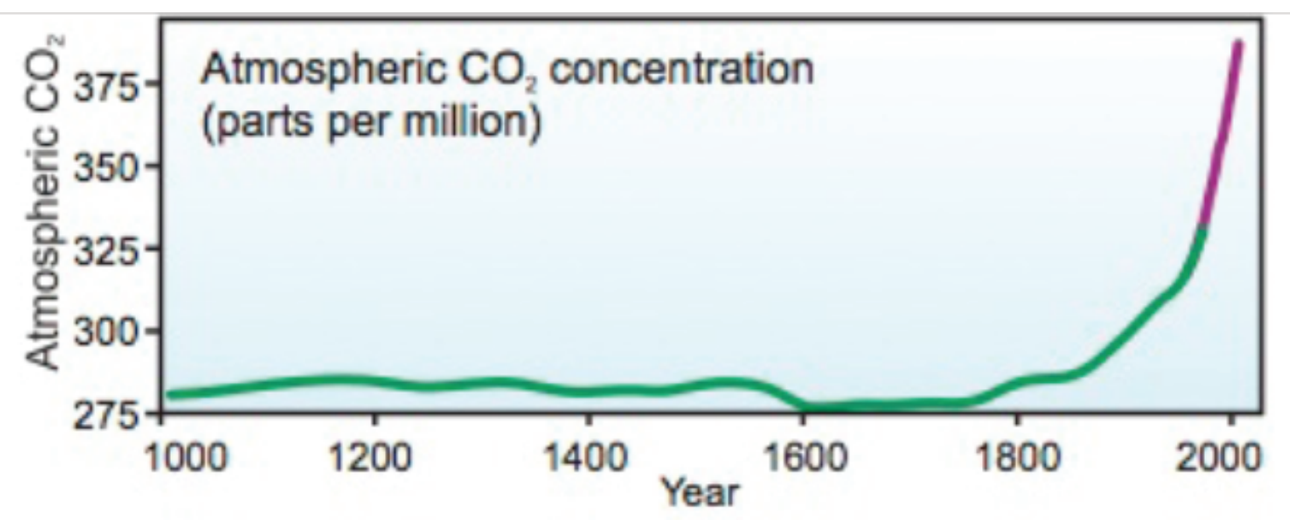
Formative Assessment





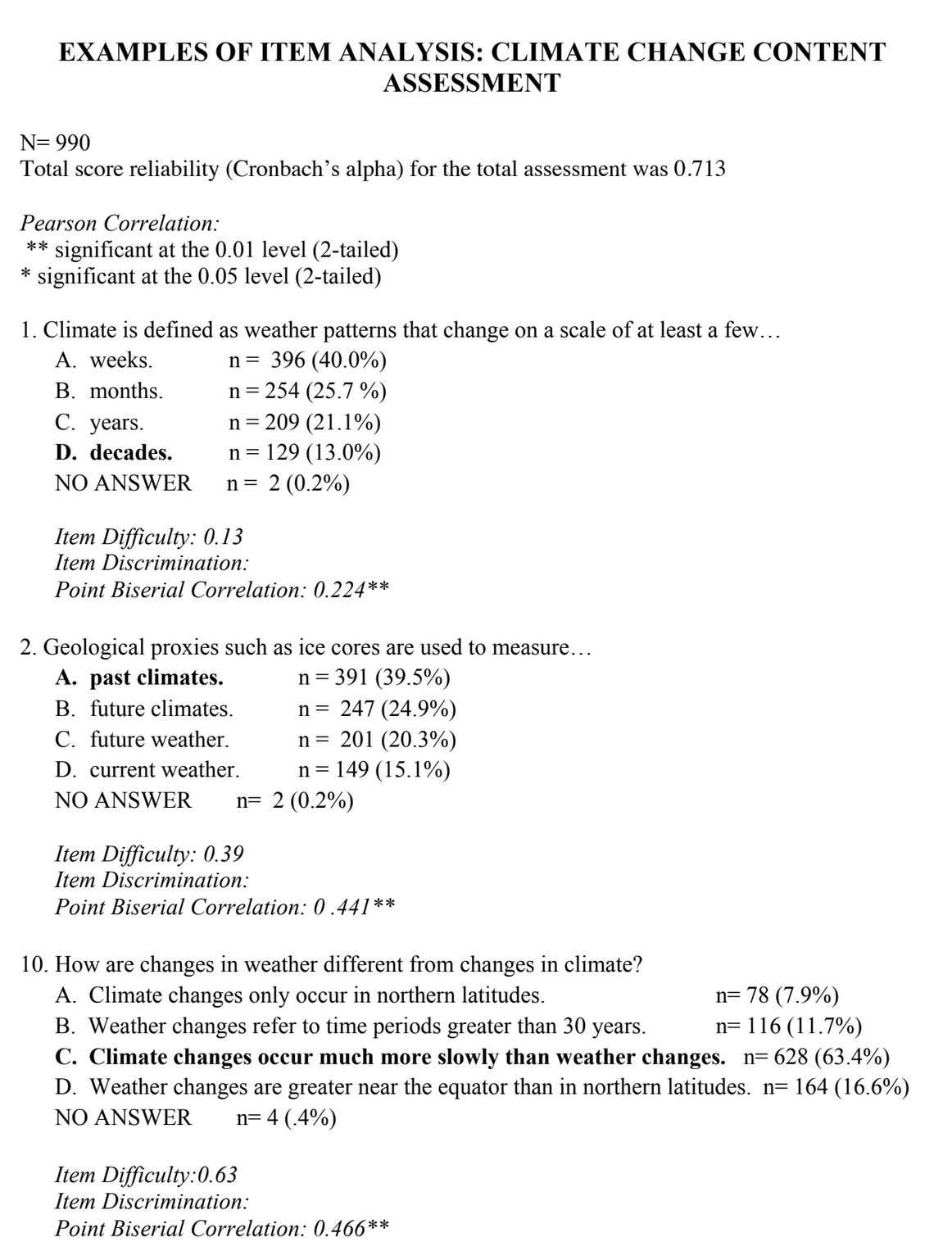


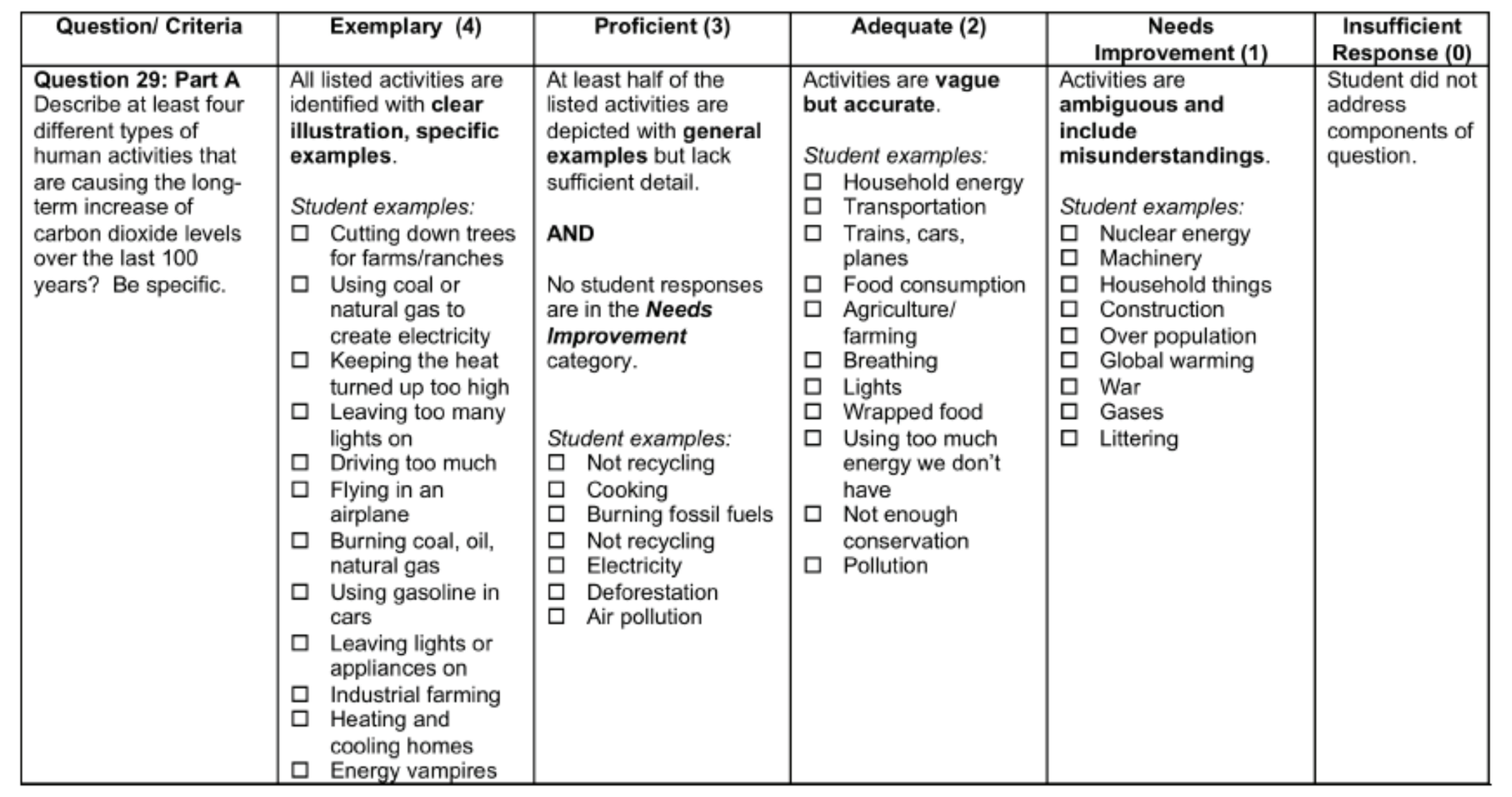
Assement Items Aligned to Misconceptions



The graph above shows the change in carbon dioxide (CO_2) concentration in the atmosphere.

29. 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? Be specific.





Dissemenation

–Publically Available web site

–Journal Articles
Dempsey et al., in press. Science Scope,
Dempsey et al., in review. Science Scope
Kulo and Bodzin, 2009. Journal of Geography, v. 108, 186-197; 2011, v. 110, 239-251

–Book Chapters
Kulo et al., in press. in Barnett, MaKinster, & Trautman (Eds.) Learning Science through the innovative use of Geospatial Technologies: Designing Effective Learning Tools and Programs for K-16 settings. Dordrecht, Netherlands: Springer. Invited book chapter.
Bodzin et al., in press. in MaKinster, Trautmann, & Barnett (Eds.) Teaching Science and Investigating Environmental Issues with Geospatial Technology: Designing Effective Professional Development for Teachers. Dordrecht, Netherlands: Springer.

–Professional Conferences
2009 Association for Educational Communications and Technology
2009 National Educational Computing Conference
2010 North American Association for Environmental Education
2011 National Association for Research in Science Teaching on slides
2011 International Society for Technology in Education
2009, 2011 Geological Society of America
2011 American Geophysical Union

–Teacher Professional Development
Bethlehem Area School District

–Preservice Teachers
Lehigh University

Educational Philosophy

Align Instructional Materials and Assessments with Science Literacy Learning Goals

Use Geospatial Technology as a Tool for Learners to Explore and Investigate Problems

Contextualize the Learning of Key Ideas in Real-World Problems

Support Teachers in Adopting and Enplementing GIT and Inquiry-Based Activities

Iterative Stages of Development:
Prototype, Pilot Test, and Field Test with Diverse 8th Grade Classrooms

School Population

Five eighth grade earth and space science classes participated in this study. The majority of the students are from low-income households in an urban middle school of 630 students in the northeast United States. The school contains a substantial migratory population, with 20% of the students transferring to the school during the academic year. A large percentage (81%) of students participate in the free and reduced lunch program. The sample consisted of 109 eighth grade students with diverse ethnic backgrounds (67% Hispanic, 19% White, 13% Black, 1% Asian) and included 11 students withIndividual Education Programs (IEPs). Student classes are divided into academic tracked ability levels that are determined by mathematics achievement on the state standardized test. Low track students scored below grade level on the standardized test, middle track students scored at grade level, and most upper track students scored above grade level.

For More Information:

Curriculum, Support Materials, and Publications

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

To Access Assessments:
Login: eliteacher
Password: 87dja92