



Investigation 1.2: Earth System Science

Objectives:

Upon completion of this investigation, students will:

- Develop the ability to work cooperatively, listen to and respect explanations proposed by other students, as well as remain open to new ideas, other's skepticism and alternative explanations, as scientists do.
- Understand that energy is a property of many substances, it takes many forms and is transferred in many ways. The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. These processes occur in the atmosphere, biosphere, geosphere and hydrosphere.
- Understand that geosciences are sciences (i.e. physics, chemistry, geology, etc.) that are used in a variety of fields (oceanography, atmospheric science, etc.) to research and study the earth and its processes.
- Use a model to analyze the constituent elements of solid earth. It is layered with a lithosphere; hot, convecting mantle; and a dense, metallic core.
- Know that lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
- Know that landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
- Analyze and understand that water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
- Understand that water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.
- Communicate, written and orally, explanations based on logical thinking and evidence.

Method(s):

- Teacher-led discussion and demonstration of background information.
- Whole class participates in an activity and then responds in their journal to the information just taught.

Background:

Note: Have available as a transparency, a handout, in student journal or online.

- What are Earth's Systems?
- What are Earth's Processes?
- What are Geosciences?

For reference:

- What are a few things I should know about Chemistry, Physics and the Science of Light?
- What is the scientific method?
- What are the skills and abilities of scientific inquiry?

Materials:

- Diagrams: Layers of the Earth, Energy, Water, and Carbon Cycles
- Hard-boiled egg, cut in half across its width as a model for layers of the earth
- Optional, light source to represent the sun
- Earth System Science - Student Journal Page(s)
- Activity: [“Water Wonders”](#) (Waterwonders.pdf) from Project Learning Tree
- Reading, “Water: The Sum of its Parts” NSTA Physical Oceanography

Assessment:

- Performance and Personal Communication Assessments. Teacher observes student’s performance and asks questions during the demonstration and activity to gauge their understanding of concepts.
- Constructed Response Assessment. Students will respond in their science journals to the lab activity and to some extension questions.

Procedures:

- 1) Prior to class, set-up the room for the “Water Wonders” activity and be prepared to do the Earth Layers demonstration.
- 2) Begin class with a discussion asking students, “What makes the Earth unique and able to support life?” Allow students to brainstorm ideas.
- 3) Using the background information, diagrams and demonstration to introduce the following concepts and terminology:
 - The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core. These layers can be illustrated using a hardboiled egg cut in half across its width.
 - Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Can be demonstrated by sliding a piece of eggshell across the surface of the egg.
 - Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions (two pieces of eggshell coming together). Land forms are the result of a combination of constructive and destructive forces or processes. Some constructive forces are a volcanic eruption or deposition of sediment, while destructive forces include weathering and erosion.
- 4) The part of the earth that we have been talking about thus far is the “geosphere”. The geosphere as we have described it interacts with other “spheres” or systems to support life. These other systems are the atmosphere, biosphere and hydrosphere. (Idea, to help remember the “spheres” is to remember the first letter of each word... A, B, G, H).
- 5) Processes occur amongst these spheres or systems, such as, water cycle. The movement of materials amongst the systems is possible because of energy. Refer to the energy cycle diagram to illustrate the concepts being discussed.
 - The sun is a major source of energy for changes on the earth’s surface (other sources include geothermal and tidal action). The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. This could be demonstrated by using a light bulb to represent the sun emitting light/heat out into space and a fraction of it reaching the earth/egg.

- The sun is that major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.
 - Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
- 6) Use the diagrams to illustrate the energy, carbon, and water cycles. Discuss how materials cycle amongst the various systems. Ask students to identify “Reservoirs or Sinks” (an area where a substance is stored) and “Pathways” (the processes by which a substance moves from one area to another). Discuss that volume of a substance and the rate at which it moves through the system are both important. Ask questions of the class to have them explain the diagrams and concepts. Encourage use of scientific vocabulary and inquiry skills.
 - 7) Now that we have an understanding of some basic concepts, we are going to complete an activity that demonstrates a substance moving through Earth’s systems. Facilitate the “[Water Wonders](#)” activity from Project Learning Tree. (Download WaterWonders.PDF for the activity.)
 - 8) Have students reflect and respond to the activity in their journal. Extension questions also included.

Extensions:

- Another method of teaching these concepts would be to set up labs/stations in various parts of the room. Ideally, labs would be experiments, demonstrations, models, and projects or performances that relate to the atmosphere, biosphere, geosphere and hydrosphere. Small groups of students would either specialize in one area and would need to communicate their knowledge and understanding with classmates or small groups could rotate through the lab activities.
Possible Biosphere Lab <http://www.arm.gov/docs/education/lessons/2act3.2.html>

Excellent books for information and lessons are:

National Science Teacher Association. (2001). *Project Earth Science Series: Astronomy, Geology, Meteorology and Physical Oceanography*. NSTA Press: Arlington, VA.

- Build and maintain a terrarium. This activity provides students with the opportunity to understand the requirements and interrelationships between the various components of a closed environment and how they work together to make life possible. See an example at <http://ericir.syr.edu/> Lesson Plan # AELP-ECL0118
- Visit Columbia University’s Biosphere 2 Project at <http://www.bio2.edu> Visit the education portion of their website for activities relating to earth systems and processes.

Additional Resources:

Earth System Resources for Teachers and Students <http://www.scilinks.org> (Code:PESG31)

Encyclopedia of the Atmospheric Environment

<http://www.doc.mmu.ac.uk/aric/eae/english.html>