Informational Text Strategies: Systems Thinking Analysis

Rationale:

The Earth is a dynamic planet in which matter is cycled through the air of its atmosphere, the oceans, rivers and water of its hydrosphere, the rocks and solid materials of its geosphere, and the living things of its biosphere. This occurs by processes such as evaporation, erosion, convection currents, transpiration, photosynthesis and weathering. Change occurs at different rates and in different places over time and is driven by the flow of energy from the Sun and from within the Earth itself.

The way the Earth works is very complex, but can be better understood by using a "systems-thinking" approach. A system is a group of related features or objects that are organized in some way. In a "systems thinking" approach, the parts or components of a system and their interactions are established. Additionally, the energy that drives these interactions is identified. Together, the different parts of a system and the processes by which they interact cause the system to function as a dynamic whole. If some of the parts are not working well, or are removed, the system will not function properly.

One method for helping students to develop their systems thinking perspective and to better understand the Earth is to have them apply a *Systems Thinking Analysis* to Earth science informational text. Informational text sources such as EARTH magazine and articles from NASA, the US Geological Survey, and others provide a wealth of information about intriguing Earth science topics. These sources offer engaging content that will motivate students to apply strategies, such as the *Systems Thinking Analysis*, designed to help them understand difficult Earth science concepts and strengthen their connection to the Earth on which they live.

Learning Goal

The goal of this activity is to have students analyze Earth science informational text using a systems-thinking approach. First, students review (or are introduced to) each of the spheres that comprise the Earth system (i.e. atmosphere, biosphere, geosphere, hydrosphere). Next, students read a selected Earth science informational text article. Then, they determine which parts of the article describe or are related to each of the Earth's different spheres. They record their findings on a *Systems Thinking Analysis* diagram. After this, students participate in a collaborative conversation with a group in which they share their ideas. The group then creates a poster that portrays the systems and system interactions described in the article. Finally, students share their poster with the class.

Background

Within the boundary of the Earth is a collection of four interdependent parts called spheres. Earth's spheres include the geosphere, the atmosphere, the hydrosphere, and the biosphere. These spheres are closely connected and a change in one sphere often results in a change in one or more of the other spheres.

The geosphere includes the crust and the interior of the planet. It contains all of the rocky parts of the planet, the processes that cause them to form, and the processes that have caused them to change during Earth's history. There are thousands of parts and processes in the geosphere. It has parts that can be as small as a mineral grain or as large as the ocean floor. Some processes act slowly, like the gradual wearing away of cliffs by the sea. Others are more dramatic, like the violent release of gases and magma during a volcanic eruption.

The fluid spheres are the liquid and gas parts of the Earth system. The atmosphere includes the mixture of gases that surrounds the Earth. The hydrosphere includes the planet's water system. Its parts include oceans, lakes, rivers, and frozen water in glaciers. A special property of the fluid spheres is that their materials flow. Processes in the fluid spheres include the water cycle, the circulation of the atmosphere and oceans, and weather.

The biosphere contains the living and once-living parts of the Earth system. It is organized into complex webs of organisms. It also includes dead and decomposing once-living things and molecules from once-living material. Processes vary from simple predator-prey relationships to changes over millions of years in the kinds of living things that make up communities. This part of the Earth system is distributed widely across the Earth, from the cold dark depths of the oceans, to the thick rainforest near the Equator.

Materials

Enough printed copies of the text passage for each student to have her or his own copy. Links to suggested texts are:

- EARTH Magazine: Travels in Geology: A trek through Himalayan geology in Nepal http://www.earthmagazine.org/article/travels-geology-trek-through-himalayan-geology-nepal
- EARTH Magazine: A journey to Pluto and beyond with New Horizons: http://www.earthmagazine.org/article/journey-pluto-and-beyond-new-horizons
- USGS: Science for Volcano Hazards: http://www.usgs.gov/blogs/features/usgs_top_story/science-for-volcano-hazards/
- NASA: How the Earthquake affected Earth: http://science.nasa.gov/science-news/science-at-nasa/2005/10jan_earthquake/

Students should have their own pen or pencil for completing the *Earth Systems Diagram*.

Earth Systems Diagram, displayed for all students to see.

Earth Systems Diagram, one per student.

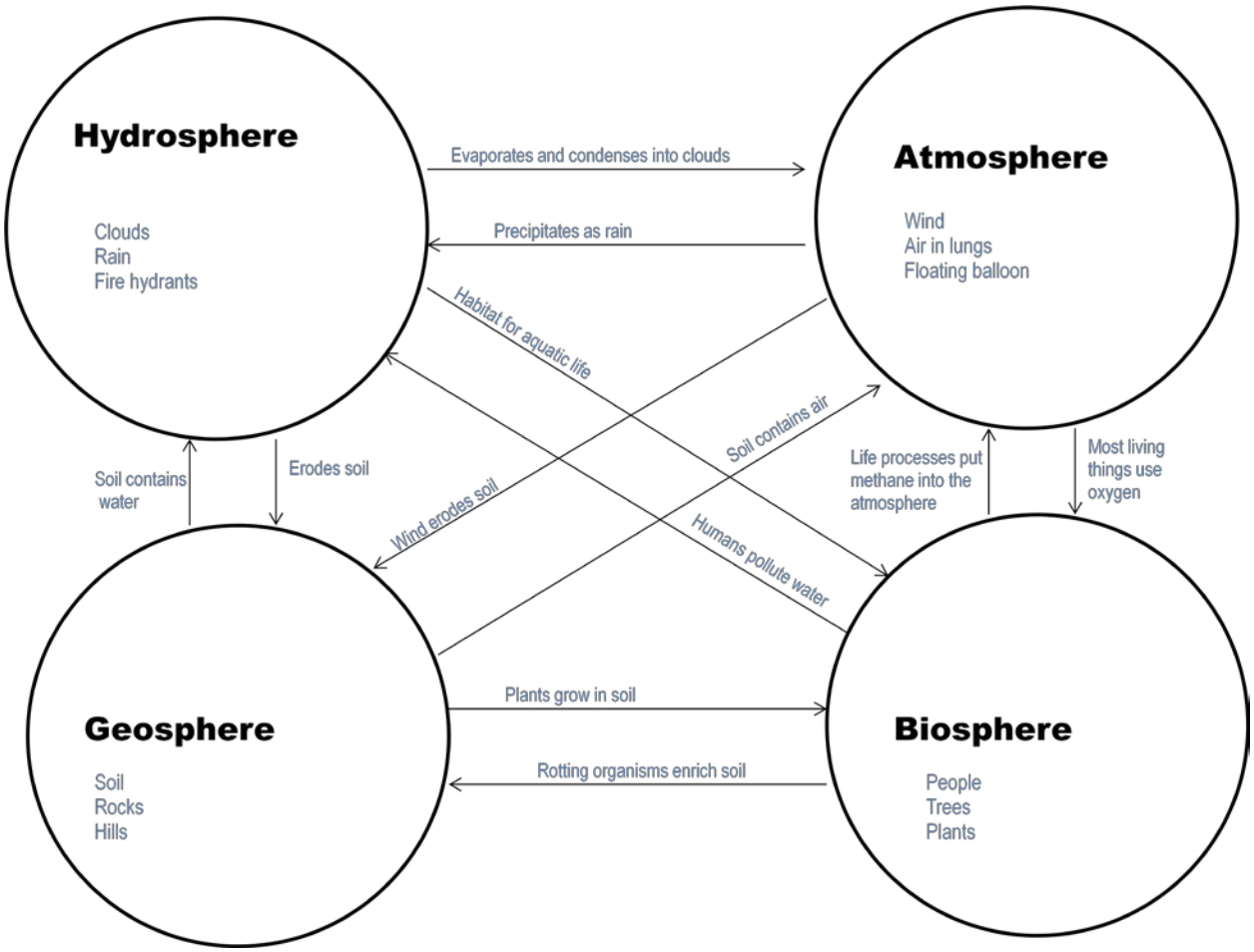
For each group:

- Copy of the *Earth Systems Diagram*
- Poster Paper
- Markers/colored pencils
- Copy of an informational text article
- Pencil
- Copy of the *Collaborative Poster Rubric*

Procedure:

1. Display the *Earth Systems Diagram* to students. As a class, discuss each sphere represented on the diagram. You may want to use the information provided in the Background section to help guide your discussion. Prompt students to identify the parts of each sphere. Write these down in each sphere circle. Prompt them to identify the processes by which spheres interact and

write these down along the arrows that connect sphere circles. Following is an example diagram (the blue text denotes the examples).



2. After students have developed a basic grasp of the Earth's spheres, ask them to read one of the selected articles provided in the materials section. Tell them that as they read, they should look for descriptions of the Earth's different spheres within the text. Ask them to annotate these passages using letters that represent each sphere (e.g. A=atmosphere, B=Biosphere, G=geosphere, and H=hydrosphere). Additionally, ask them to annotate passages that describe sphere interactions by drawing arrows between letters that represent the interdependent spheres (e.g. "A→H" can be used to highlight a passage that describes the atmosphere affecting the hydrosphere).
3. Provide each student a copy of the *Earth Systems Diagram*. Ask them to transfer the sphere descriptions they identified in the article to the diagram.
4. Break students into groups. Provide a copy of the *Collaborative Poster Rubric* to each group. Explain that each group is to create a poster that illustrates the systems interactions described in their article. This includes the parts of the various spheres as well as the processes by which they interact. Groups should use their *Earth Systems Diagrams* to guide their work. Encourage them to be creative in the presentation of their findings. Tell students that their work will be evaluated according to the *Collaborative Poster Rubric*. Encourage students to look over the rubric and consider how they can best achieve the "Outstanding" criteria in each row of the rubric. When they are ready, groups can begin their work. *Note: If a group is having difficulty*

deciding how to represent their information, you may want to suggest a concept map that includes arrows of different colors representing positive and negative interactions.

5. Bring the class together and have each group share its poster. Presentations can address such questions as: What did you learn from the text? What Earth system interactions did you identify? How do different spheres interact with each other? Did you agree or disagree with the findings of others in your group?
6. (About 5 minutes) After all of the groups have presented, have the class consider each of the Earth's spheres. Have them explain whether they feel the evidence provided in the articles they read is strong for how the Earth's spheres interact. Discuss any questions that students may have about the text and how the Earth works.

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Assessment:

Use the following rubric to assess group work on the poster.

Performance Indicators	Outstanding	Passing	Needs Revision
Contents	• Shows many Earth system interactions. • Successfully communicates the Earth system processes described in the informational text. • Identifies the evidence provided in the informational text for each part and process described. • Assesses reasoning effectively.	• Includes one relevant Earth system interaction. • Communicates something about the Earth system processes described in the informational text. • Identifies most of the evidence provided in the informational text for each part and process but some may have been left out or unrelated ideas are included. • Assesses evidence and reasoning effectively for the most part.	• Does not illustrate any Earth system interactions. • Fails to communicate the Earth system processes described in the informational text. • Does not identify the evidence provided n the informational text for each part and process described. • Does not assess evidence and reasoning effectively.
Presentation	• Uses creative design to amplify Earth system interactions. • Uses color or shading effectively. • Product is neat.	• Design does not detract from the Earth system interactions. • Uses color and shading. • Product is neat, for the most part.	• Design detracts from the meaning of the Earth system interactions. • Poster does not use color or shading. • Product is sloppy.
Collaboration with Peers	• Each student is actively involved in the planning process and contributes ideas to the creation of the final product. • All group members encourage peers to participate and share their ideas.	• Each student pays attention and contributes in the planning process and creation of the final product. • All group members respond to each other's ideas.	• One or more group members fails to pay attention or contribute in the planning process and the creation of the final product. • One or more group members do not contribute or participate.

References:

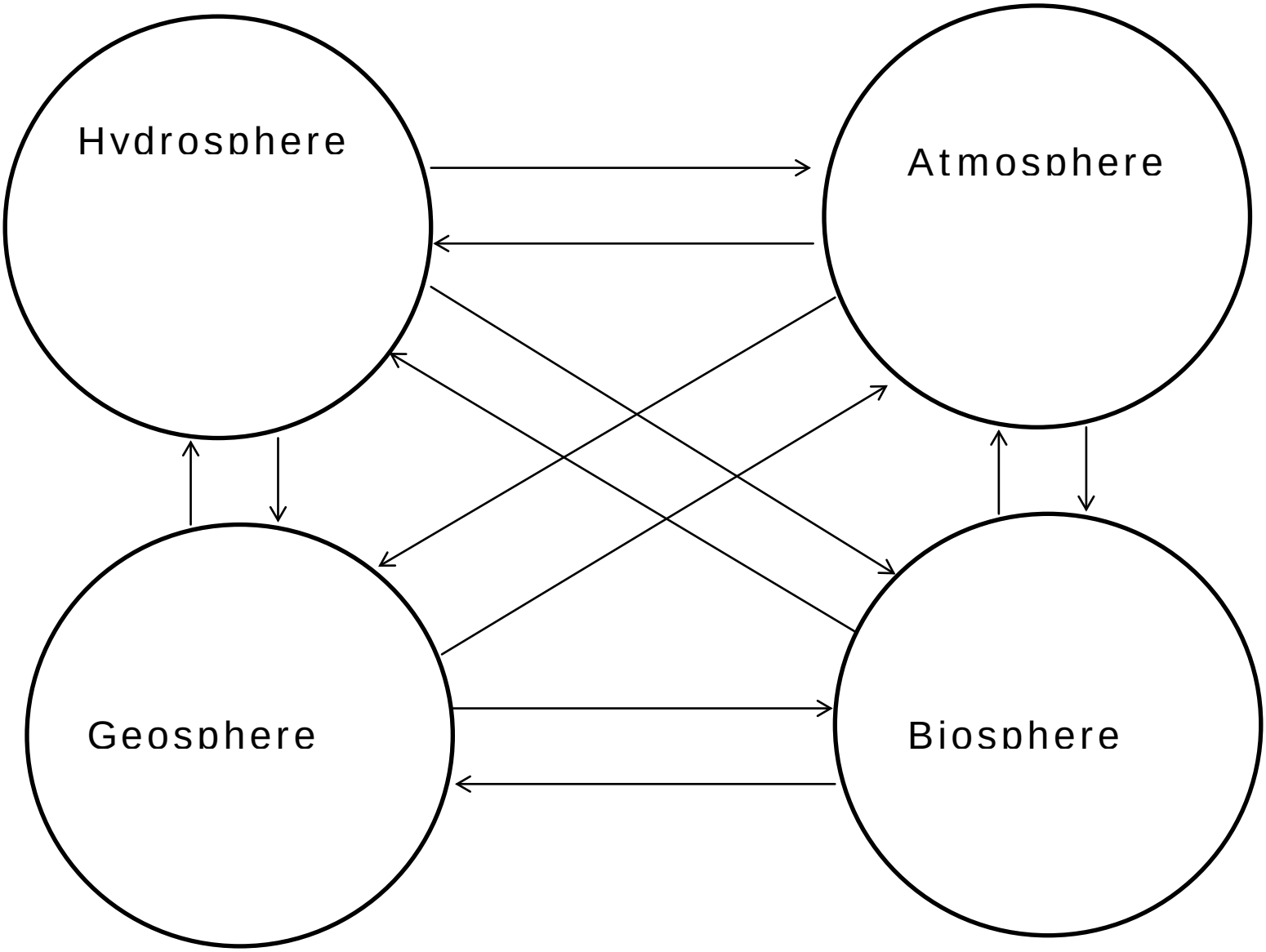
Provencher, A. (n.d.). *Collaborative Poster (QTEL)*. Retrieved from http://teambsesnyc.wikispaces.com/file/view/Collaborative+Poster+Rubric.pdf

Smith, M. J, Southard, J. B, & Mably, C. (2002) *Investigating earth systems, our dynamic planet*, Armonk, NY It's About Time.

Sussman, A. (2000). *Dr. Art's guide to planet earth for earthlings ages 12- 120*. White River Junction, VT Chelsea Green Publishing Company.

Stanley, S. M. (2005) *Earth system history second edition*. W.H. Freeman and Company, New York

Earth Systems Diagram



Collaborative Poster Rubric

Performance Indicators	Outstanding	Passing	Needs Revision
Contents	• Shows many Earth system interactions. • Successfully communicates the Earth system processes described in the informational text. • Identifies the evidence provided in the informational text for each part and process described. • Assesses reasoning effectively.	• Includes one relevant Earth system interaction. • Communicates something about the Earth system processes described in the informational text. • Identifies most of the evidence provided in the informational text for each part and process but some may have been left out or unrelated ideas are included. • Assesses evidence and reasoning effectively for the most part.	• Does not illustrate any Earth system interactions. • Fails to communicate the Earth system processes described in the informational text. • Does not identify the evidence provided n the informational text for each part and process described. • Does not assess evidence and reasoning effectively.
Presentation	• Uses creative design to amplify Earth system interactions. • Uses color or shading effectively. • Product is neat.	• Design does not detract from the Earth system interactions. • Uses color and shading. • Product is neat, for the most part.	• Design detracts from the meaning of the Earth system interactions. • Poster does not use color or shading. • Product is sloppy.
Collaboration with Peers	• Each student is actively involved in the planning process and contributes ideas to the creation of the final product. • All group members encourage peers to participate and share their ideas.	• Each student pays attention and contributes in the planning process and creation of the final product. • All group members respond to each other's ideas.	• One or more group members fails to pay attention or contribute in the planning process and the creation of the final product. • One or more group members do not contribute or participate.