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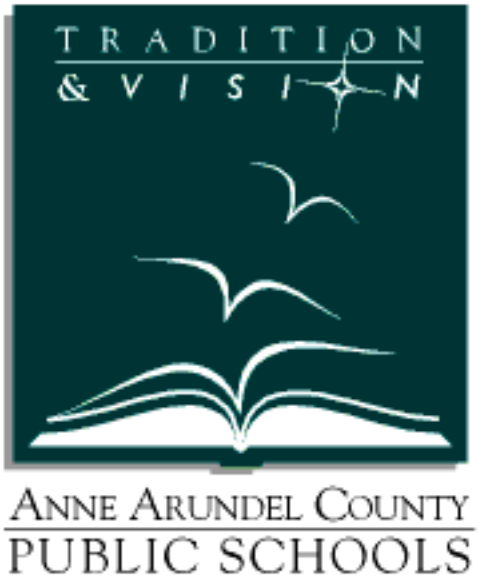

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Earth Space Systems Science

Unit 7: Student Investigation

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Earth Space Systems Science
Unit 7: Student Investigation

Description

This unit provides an opportunity for students to meet Expectation 2.8 of the Science ore Learning Goals: The student will know how to investigate an earth science issue to develop an action plan.

Student will investigate and analyze an "event" in the Earth Space system. Earth systems scientists consider an "event" an activity or action or problem that results when a system or subsystem is out of equilibrium (such as a hurricane) or something that may perturb a system (perhaps the hole in the ozone layer. As part of the student activity, students will explain some of the ways the systems and subsystems of the related earth and space spheres behave and interact.

Students will use analysis tools that have been practiced throughout this course to analyze their chosen event. Students will research how their event impacts each of the spheres and how each of the spheres impacts the event.

Key questions for this unit are:

1. How do energy balance and conservation of energy relate to the event chosen by the student?
2. How do mass balance and conservation of mass relate to the event chosen by the student?
3. How does the "event" relate to other events that occur?
4. How does the event affect each of the earth/space systems and subsystems?
5. How do each of the earth/space systems and subsystems affect the event?

Key Concepts

· Energy can be transferred and matter can be changed. Nevertheless, when measured, the sum of energy and matter in systems, and by extension, in the universe, remains the same. (NSES, p. 118)

· Thinking and analyzing in terms of systems will help students keep track of mass, energy, organisms, and events. (NSES, p. 118)

· Simple systems encompass subsystems, feedback and equilibrium, and the distinction between open and closed systems. (NSES, p. 116)

· Evidence consists of observation and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and artificial systems. (NSES, p. 117)

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- Changes in systems can be quantified. (NSES, p. 118)

- Scale includes understanding that different characteristics, properties, or relationships within a system might change as its dimensions might increase or decrease. (NSES, p. 118)

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CONTENT OUTLINE

Unit 7: Analyzing an Earth/Space System

I. Review of Earth/Space Systems
II. Identification of Event/ Effect/ Problem
    A. Nuclear disaster
    B. Climate change
    C. Asteroid impact
    D. Destruction of rainforest
    E. Overpopulation
    F. Floods
    G. Fire
    H. Hurricane
    I. Epidemic
    J. Hole in ozone layer
    K. Solar max and solar storms
    L. Other
III. Model
IV. Analysis
V. Action Plan

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Science Core Learning Goals

Goal 1: Skills and Processes

The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information.

Expectation 1.1

The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.

1.1.1 The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues.
1.1.2 The student will modify or affirm scientific ideas according to accumulated evidence.
1.1.3 The student will critique arguments that are based on faulty, misleading data or on the incomplete use of numbers.
1.1.4 The student will recognize data that are biased.
1.1.5 The student will explain factors that produce biased data.

Expectation 1.2

The student will pose scientific questions and suggest experimental approaches to provide answers to questions.

Indicators

1.2.1 The student will identify meaningful, answerable scientific questions.
1.2.2 The student will pose meaningful, answerable scientific questions.
1.2.3 The student will formulate a working hypothesis.
1.2.4 The student will test a working hypothesis.
1.2.5 The student will select appropriate instruments and materials to conduct an investigation.
1.2.6 The student will identify appropriate methods for conducting an investigation and affirm the need for proper controls in an experiment.
1.2.7 The student will use relationships discovered in the lab to explain phenomena observed outside the laboratory.
1.2.8 The student will defend the need for verifiable data.

Expectation 1.3

The student will carry out scientific investigations effectively and employ the instruments, systems of measurement, and materials of science appropriately.

Indicators

1.3.1 The student will develop and demonstrate skills in using lab and field equipment to perform investigative techniques.
1.3.2 The student will recognize safe laboratory procedures.
1.3.3 The student will demonstrate safe handling of the chemicals and materials of science.
1.3.4 The student will learn the use of new instruments and equipment by following instructions in a manual or from oral direction.

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Expectation 1.4

The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.

Indicators

1.4.1 The student will organize data appropriately using techniques such as tables, graphs, and webs (for graphs: axes labeled with appropriate quantities, appropriate units on axes, axes labeled with appropriate intervals, independent and dependent variables on correct axes, appropriate title).

1.4.2 The student will analyze data to make predictions, decisions, or draw conclusions.

1.4.3 The student will use experimental data from various investigators to validate results.

1.4.4 The student will determine the relationships between quantities and develop the mathematical model that describes these relationships.

1.4.5 The student will check graphs to determine that they do not misrepresent results.

1.4.6 The student will describe trends revealed by data.

1.4.7 The student will determine the sources of error that limits the accuracy or precision of experimental results.

1.4.8 The student will use models and computer simulations to extend his/her understanding of scientific concepts.

1.4.9 The student will use analyzed data to confirm, modify, or reject an hypothesis.

Expectation 1.5

The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.

Indicators

1.5.1 The student will demonstrate the ability to summarize data (measurements/observations).

1.5.2 The student will explain scientific concepts and processes through drawing, writing, and/or oral communication.

1.5.3 The student will produce the visual materials (tables, graphs, and spreadsheets) that will be used for communicating results.

1.5.4 The student will create and/or interpret graphics (scale drawings, photographs, digital images, etc.).

1.5.5 The student will use computers and/or graphing calculators to produce tables, graphs, and spreadsheet calculations.

1.5.6 The student will read a technical selection and interpret it appropriately.

1.5.7 The student will use, explain, and/or construct various classification systems.

1.5.8 The student will describe similarities and differences when explaining concepts and/or principles.

1.5.9 The student will communicate conclusions derived through a synthesis of ideas.

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Expectation 1.6

The student will use mathematical processes.

Indicators

1.6.1 The student will use ratio and proportion in appropriate situations to solve problems.

1.6.2 The student will use computers and/or graphing calculators to perform calculations for tables, graphs, or spreadsheets.

1.6.3 The student will express and/or compare small and large quantities using scientific notation and relative order of magnitude.

1.6.4 The student will manipulate quantities and/or numerical values in algebraic equations.

1.6.5 The student will judge the reasonableness of an answer.

Expectation 1.7

The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.

Indicators

1.7.1 The student will apply the skills, processes, and concepts of biology, chemistry, physics, and earth science to societal issues.

1.7.2 The student will identify and evaluate the impact of scientific ideas and/or advancements in technology on society.

1.7.3 The student will describe the role of science in the development of literature, art, and music.

1.7.4 The student will recognize mathematics as an integral part of the scientific process.

1.7.5 The student will investigate career possibilities in the various areas of science.

1.7.6 The student will explain how development of scientific knowledge leads to the creation of new technology and how technological advances allow for additional scientific accomplishments.

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Goal 2: Concepts of Earth/Space

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain the physical behavior of the environment, earth, and the universe.

Expectation 2.1

The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.

Indicators

2.1.1. The student will describe current efforts and technologies used to study the atmosphere, land, and oceans of the Earth.
At least– remote sensing from space, undersea exploration, seismology, weather data collection

2.1.2. The student will describe current efforts and technologies used to study the universe.
At least– optical telescopes, radio telescopes, spectroscopes, satellites, space probes, manned missions.

Expectation 2.2

The student will describe and apply the concept of natural forces in the study of Earth/Space Science.

Indicators

2.2.1. The student will explain the role of natural forces in the universe.
At least– formation of planets, orbital mechanics, stellar evolution.

2.2.2. The student will explain the role of natural forces in the earth.
At least– retention of an atmosphere, an agent of erosion and deposition, tides and deep ocean currents

Expectation 2.3

The student will explain how the transfer of energy affects weather and climate.

Indicators

2.3.1. The student will describe heat transfer systems in the atmosphere, on land, and in the oceans.
At least – convection, conduction, radiation from space and from within Earth

2.3.2. The student will investigate meteorological phenomena
At least – hurricanes, tornadoes, floods, thunderstorms, blizzards

2.3.3. The student will research topics of current concern with regard to climate.
At least – greenhouse effect, global warming (or cooling), ocean currents

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Expectation 2.4

The student will describe Earth's surface and the theory of plate tectonics and explain the dynamic nature of Earth's crust.

Indicators

2.4.1. The student will describe the structure of the Earth.
At least – inner core, outer core, mantle, lithosphere- crust and upper mantle

2.4.2. The student will identify common rock-forming mineral groups using a key and properties of minerals.
At least – hardness, luster, specific gravity, streak, color, cleavage

2.4.3. The student will use texture and composition to describe various types of rocks
At least – igneous, sedimentary, metamorphic

2.4.4. The student will apply the law of conservation to the processes that affect rocks and minerals.
At least – metamorphism, weathering, erosion, deposition, melting, crystallization

2.4.5. The student will explain the dynamic activity of the earth
At least – plate tectonics, sea floor spreading, faulting, earthquakes, and volcanoes

Expectation 2.5

The student will know how to connect prior understanding and new experiences to evaluate natural cycles.

Indicators

2.5.1. The student will investigate various physical cycles found in the natural world.
At least – rock cycle, water cycle, tides, lunar phases, eclipses, seasons

2.5.2. The student will analyze the effects of natural cycles on human activity.
At least – weathering, erosion and deposition, agriculture, aquaculture

Expectation 2.6

The student will investigate how the political climate affects the development of a scientific theory or model.

Indicators

2.6.1. The student will research various planetary models.
At least: Ptolemy, Copernicus, Kepler, and Galileo

2.6.2 The student will research the change in the belief in the age of the earth.
At least– fossil record, rock layers, radioactive dating, Big Bang theory

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Expectation 2.7

The student will know how to use measurement of different orders of magnitude to construct an earth science model.

Indicators

2.7.1. The student will create a geologic time scale including eras, periods, and epochs. At least – analogies, ratios, scale drawings, powers of ten

2.7.2. The student will create a geologic time scale including eras, periods, and epochs. At least – analogies, ratios, scale drawings, powers of ten

2.7.3. The student will construct a model to show human's place in the time continuum.

Expectation 2.8

The student will know how to investigate an earth science issue to develop an action plan.

Indicators

2.8.1. The student will investigate an issue such as climatic changes or electric power generation

2.8.2. The student will identify data that are biased.

2.8.3. The student will use tables, charts, and graphs in making oral and written presentations.

2.8.4. The student will know why curiosity, honesty, openness, and skepticism are highly regarded in science.

2.8.5. The student will understand that real problems have more than one solution, and the decisions to accept one solution over another are made on the basis of many issues.

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SCIENCE RUBRIC

LEVEL 4

There is evidence in this response that the student, using analysis, has a full and complete understanding of the question or problem.

- The student has synthesized information to provide a correct answer.
- The supporting evidence consists of an integration of ideas.
- The student has effectively applied the information to a practical problem in a related area of science, mathematics, or technology.
- The response is enhanced through the use of accurate terminology to explain scientific principles.

LEVEL 3

There is evidence in this response that the student, using analysis, has a good understanding of the question or problem.

- The student has synthesized information to provide a correct answer.
- The supporting evidence is complete.
- The student has applied the information to a practical problem within the particular concept area of science.
- The response uses mostly accurate terminology to explain scientific principles.

LEVEL 2

There is evidence in this response that the student has a basic understanding of the question or problem.

- The student provides a correct answer.
- The supporting evidence is only moderately effective.
- The student has applied the information to a practical problem within the scope of the question.
- The response uses limited accurate terminology to explain scientific principles.

LEVEL 1

There is evidence in this response that the student has some understanding of the question or problem.

- The student provides a partially correct answer.
- The supporting evidence is only minimally effective.
- The student has attempted to apply the information.
- The response makes little or no use of accurate terminology to explain scientific principles.

LEVEL 0

There is evidence that the student has no understanding of the question or problem.

- The response is completely incorrect or irrelevant, or there is no response

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Scoring Criteria for Graphs

The student will organize data appropriately using a graph.

Level 4
Data are accurately plotted (90-100%) and the graph includes nine of the ten elements.

Level 3
Data are accurately plotted and the graph includes seven of the ten elements,
OR
data are mostly accurate (80-89%) and the graph includes nine of the ten elements.

Level 2
Data are accurately plotted and the graph includes five of the ten elements,
OR
data are generally accurate (70-79%) and the graph includes seven of the ten elements.

Level 1
Data are accurately plotted and the graph includes three of the ten elements
OR
Data are somewhat accurate (60-69%) and the graph includes five of the ten elements.

Level 0
Data are inaccurately plotted (<60%) or the graph includes fewer than five elements.

ELEMENTS OF THE GRAPH

- Appropriate title
- X-axis labeled correctly with appropriate quantities/variables
- X-axis labeled correctly with appropriate units
- Appropriate intervals indicated on the X-axis
- Given the length of axes on the grid, the scale is appropriate for the range of data
- Y-axis labeled correctly with appropriate quantities/variables
- Y-axis labeled correctly with appropriate units
- Appropriate intervals indicated on the Y-axis
- Given the length of axes on the grid, the scale is appropriate for the range of data

Origin correctly identified

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Lesson Planning Organizer

LESSON	TOPIC	APPROXIMATE 45 MINUTE CLASS PERIODS	OUTCOMES
1	CHOOSING AN EVENT	1-2	The student will be able to select an event for an in-depth analysis by creating a systems diagram of the Earth/Space Systems.
2	INVESTIGATING AN EVENT	1-2	The student will be able to produce and report an in-depth analysis of an earth/space event by using the skills and processes of science.
3			
4			
5			
Approximate Number of Class Periods		**10**	

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Lesson 1: Choosing an Event

Estimated Time: One to two forty-five minute class periods

Indicator(s) Core Learning Goal 1:

1.2.1 The student will identify meaningful, answerable scientific questions.
1.4.2 The student will analyze data to make predictions, decisions, or draw conclusions.

Indicator(s) Core Learning Goal 2:

2.8.1. The student will investigate an issue such as climatic changes or electric power generation.

Student Outcome(s):

The student will be able to select an event for an in-depth analysis by creating a systems diagram of the Earth/Space Systems.

Brief Description:

This lesson helps students review the numerous systems and subsystems studied throughout the scope of this course.

Background knowledge / teacher notes:
This activity will be modeled after a strategy known as creative problem solving. Instead of creating a TABA or chart product, students will create a class size systems diagram.

Although this lesson is listed to be done after the state assessment, it would be an ideal way to review many of the learning activities of this course.

Lesson Description:

ENGAGE	As a group, ask students to suggest each of the systems and subsystems and events and natural phenomena that have been studied throughout this course. After generating a substantial list, have one of the students facilitate (help order and record) as the class is able to classify the subsystems and events
EXPLORE	Ask student groups to self-select one of the spheres and create a systems diagram for each of the subsystems, events, and natural phenomena listed within the particular sphere.
EXPLAIN	***Journal Write***: Ask students to write a written description to accompany their systems diagram.

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EXTEND	Using newsprint or a large roll of paper such as brown craft paper, and other construction paper, have students create a comprehensive systems diagram. This all-encompassing diagram may be completed as a wall size display, bulletin board display, or other product. It will be a synthesis of the work of each of the groups and reflect the spheres, systems, subsystems, events, and natural phenomena the students have studied and listed. Art Connection: Some students or classes may wish to showcase their artistic talents by creating three-dimensional displays or other variations of this product.
EVALUATE	***Journal Write***: Ask students to justify the way in which the class has synthesized each of the individual spheres. The teacher may wish to narrow the focus of this journal writing by assigning a particular sphere for each group of students. Ask students to select an event or natural phenomena or earth/space systems problem that is related to one of the spheres on the systems diagram.

Materials:

Materials for creating the display-
Craft paper
Construction paper
Markers
Scissors
Paste
Tape
Rulers
Any other items that may be available and useful for students to complete this project

Resources:

Student journals and accumulated systems diagrams

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Lesson 2: Investigating an Event

Estimated Time: One to two forty-five minute class periods

Indicator(s) Core Learning Goal 1:

1.2.1 The student will identify meaningful, answerable scientific questions.
1.4.2 The student will analyze data to make predictions, decisions, or draw conclusions.

Indicator(s) Core Learning Goal 2:

2.8.1. The student will investigate an issue such as climatic changes or electric power generation.

Student Outcome(s):

The student will be able to produce and report an in-depth analysis of an earth/space event by using the skills and processes of science.

Brief Description:

Students will take a variety of different avenues to analyze their event. Students should have access to their Earth/Space Journals, Internet, text, research articles, etc. Some events may incorporate an aspect of experimental inquiry or actual model building and testing.

Background knowledge / teacher notes:

The teacher should provide the same kind of guiding questions that have been used consistently throughout the course.

GUIDE QUESTIONS

1. What do we need to know or be able to do to understand events across spheres (subsystems of the earth-space system)?
2. What do we need to know to understand systems?
    A. What are the parts/components of the system (i.e. reservoir of matter or energy)?
    B. What is the state of the system or set of attributes that characterize a system (i.e. sea surface temperature)
    C. What are the links between/among components (reflectivity of a surface [albedo] and surface temperature)
    D. What are the feedback loops involved?
    E. Is the system in equilibrium (what are the stable and unstable conditions)?
    F. How does system responds to disturbances such as an event (i.e. effects of volcanic eruption on climate)

3. What are the tools that help us understand the systems, subsystems, and events?
    A. Remote sensing
    B. Modeling
    C. Observational networks
    D. System diagram or flow chart or concept map
    E. Graphs and graphical analysis
    F. Computer analysis
4. How is energy balance/conservation of energy disturbed and maintained?
5. How is mass balance/conservation of mass disturbed and maintained?
6. Does the event "drive" a system?
7. What other events happen when the system gets out of balance?
8. What events help the system get back into balance?
9. How are the systems and subsystems of each sphere affected by the event?
10. How is the event affected by each of the systems and subsystems?

The class should generate a scoring tool for the project before work begins.

Students may wish to be creative in sharing the analysis of their event. Some suggestions are a segment of a TV news show, a video "in-depth" report, a PowerPoint presentation for inclusion in a seminar, a report to a government subcommittee, a brochure, a newspaper or magazine article, a position paper for a political campaign, or other formats deemed appropriate by the teacher and students. Different events and issues may have different formats that are appropriate.

Lesson Description:

ENGAGE	Students will work in groups (two to three students is suggested) to analyze the event of choice.
EXPLORE	Students will use the GUIDE QUESTIONS to research their event.
EXPLAIN	1. Students will create a systems diagram to show the interrelationships of the event. ***Journal Write***: Write an accompanying paragraph to explain the interrelationships depicted in the systems diagram. 2. Create a series of tables, graphs, and other illustrations that will be useful in explaining your analysis of the event. ***Journal Write***: Prepare an accompanying paragraph explaining each of the tables, charts, and graphs that have been created.
EXTEND	Create a product to communicate your event analysis with fellow students.
EVALUATE	Students will use the scoring tool to evaluate their own product. Students will then evaluate the product shared by another group. The

	teacher will provide the final evaluation. ***Journal Write***: Identify the skills and processes of science were used to conduct your analysis?

Materials:

Resources: