Course Syllabus

Title
Teaching Earth and Space Science

Target Audience
This course is intended for pre-service and in-service teachers of earth and space science in grades 5-12.

Prerequisites
To successfully participate and complete the assignments in this course, the learner must:

- Be familiar with taking an online course or have completed the PBS "Practice Learning Online with TeacherLine" course.
- Have some experience in grades K-12 classrooms.
- Have an interest in life, earth and space sciences.

Course Description
This course focuses on three elements: content knowledge, inquiry and other teaching strategies, and use of multimedia and visualization tools in teaching and learning about earth and space science. Teaching Earth and Space Science enhances educators' understanding and teaching of earth and space science. The course begins with the principles of constructivist learning and exploration-based science and work through content and methodology to give teachers a comprehensive understanding of earth and space science to encourage the learning success of students. Through the readings, videos, discussions, assignments, and other interactive experiences, learners in this course will have multiple opportunities to develop content knowledge about Earth as a system, landform processes, Earth's history, the Sun-Earth-Moon system, and weather and climate. Learners will experience a rich multimedia, inquiry-based learning environment as their students ideally would in their own classrooms. The course provides effective teaching methodologies, strategies and tools that can be used when teaching earth and space concepts.

Instructor/Facilitator
See instructor/facilitator sheet.

Credits
To be determined by college or university.

Course Goals
As a result of participating in this course learners will*:*

- Develop content knowledge about Earth as a system, landform processes, Earth's history, the Sun-Earth-Moon system, and weather and climate.
- Explore inquiry-based learning models.
- Provide a range of effective teaching methodologies, strategies, and tools for use in teaching earth and space science concepts.
- Introduce a media-rich learning environment to use with students.
- Provide models to illustrate ways to teach beyond the textbook.
- Understand and utilize the scientific process.

Outline of Content and Assignments
Learners in this course are expected to participate in discussions and complete assignments. Learners are also expected to keep a personal notebook (which is not assessed) to keep notes, complete exercises and record reflections about their learning experiences in this course.

Discussion Activities

- **Essential Question** – Each session includes a discussion about an essential question and to teaching and learning issues related to this question. Learners post responses to questions posed in the course and respond to posts submitted by their colleagues.

- **Final Project Discussion** - There is also an ongoing discussion concerning final assignment preparation.

Assignments and Final Course Project - Learners are expected to submit assignments and a final project. Rubrics are provided for assessment of all assignments, and the course content includes assignment samples.

Assignments in this course include:
- **Writing Assignments -** Short writing assignments (essays) are submitted to the facilitator.
- **Final Course Assignment: Earth as a System**
  Learners will construct an essay that summarizes how this course has influenced the way in which they teach Earth science. The essay should include the following:
    - Their ideas for how they might change their way of teaching -- either Earth science in general or a particular lesson -- to reflect their new perspective.
    - A discussion of the advantages and/or disadvantages of using an Earth system perspective as well as reasons for fostering development of systems thinking skills.
    - Examples from the course that demonstrate the importance of using visualizations, models, and data.

<u>Required Readings</u>
- Session 1:
    - "Excerpt from Earth System Science: A Closer View"
    - "Annotating a Study Site Photograph"
    - "The Earth System on Different Spatial Scales"
    - "Introduction to Earth System Science"
    - "Diagramming Earth as a System"
- Session 2:
    - "Inquiry in Science and in Classrooms"
    - "Learning through Inquiry and its Implications for Teaching"
    - "Essential Features of Inquiry (Annotated)"
- Session 3:
    - "Earth's Internal Structure"
    - "Einstein: How Smart Was He?"
    - "Tectonic Theory"
    - "Building Conceptual Understanding in Young Scientists"
- Session 4:
    - "Geologic Provinces of the United States: Appalachian Highlands Province"
    - "Using GPS to Study Plate Tectonics"
    - "Earthquake Science: Find the Fault: Recognizing Active Faults"
    - "Earthquake Science: Looking into the Past with Earthquake Trenches"
    - "Earthquake Science: When will the next big one hit? How do we know?"
    - "Earthquake Science: How do we make buildings and roads safer?"
    - "Earthquake Science: Putting Down Roots in Earthquake Country"
    - "Earthquake Science: Bay Area Tsunamis"
    - "Modified Mercalli Intensity Scale of 1931"
    - "Excerpt from Using Data in Undergraduate Science Classrooms"
- Session 5:

    - “Using Rocks to Reconstruct Earth’s History”
    - “Dating Techniques”
    - “Radiometric Time Scale”
    - “What Is Deep Time and Why Should Anyone Care?”
- Session 6:
    - “Ten Things You Thought You Knew About Sun-Earth Science”
    - “Tides and Water Levels: Gravity, Inertia, and the Two Bulges”
- Session 7:
    - “Weather Graphs”
- Session 8:
    - “Global Warming: Graphs Tell the Story”
    - “Greenhouse Effect in the Classroom: A Project- and Laboratory-Based Curriculum”

SESSION 1: ENERGY TRANSFER AND EARTH SYSTEM CYCLES

Objectives - After completing this session, learners will be able to:
- Show that Earth events taking place within the global environment are interconnected, and that these connections create interdependencies at many levels and scales.
- Describe how radiation, conduction, advection, and convection transfer energy through the Earth system.
- Explain how the atmosphere, hydrosphere, lithosphere, and biosphere interact and are responsible for the characteristics of Earth's physical features and environmental conditions.
- Outline the water cycle and carbon cycle and describe their role in integrating atmosphere, hydrosphere, lithosphere, and biosphere processes.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What is the Earth system, and how does it function to create the physical world around us?***

Activities in this session delve into what it means to look at Earth as a system. This session also introduces learners to the online course and to the experience of being a student again as they work out a common understanding of the Earth system perspective.

Assignments in this session require learners to observe and describe their local environment demonstrating an understanding of carbon cycle while using Earth system science terminology and describe how they would revise or devise a lesson plan to be system-based.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 2: INQUIRY INTO EARTH SYSTEM SCIENCE

Objectives - After completing this session, learners will be able to:
- Describe the essential elements of inquiry in the science classroom.
- Explain key findings from research about learning and apply them in the classroom.
- Discuss how an instructional model that sequences learning experiences can help students build a deeper understanding of important Earth system science concepts.
- Understand that scientists use quantitative, qualitative, experimental, and non-experimental methods of scientific inquiry to understand Earth.

- Understand that knowledge in the Earth system science, as in all scientific disciplines, is subject to revision.
- Develop strategies for improving one of your current lessons to increase the level of inquiry and to reflect understandings about how people learn.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can the nature and sequence of learning opportunities improve students' understanding of Earth system science?***

Activities in this session delve into the use of an inquiry-based approach in an Earth system science classroom, and encourage learners to reflect on the role of inquiry-based activities in their own current classroom practices.

Assignments in this session require learners to share their ideas of how an Earth science topic they have taught embodies an inquiry approach to learning and aligns with the 5E model. Learners also analyze where a given instructional scenario falls in the 5E continuum.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 3: PLATE TECTONICS AND LANDFORM PROCESSES

Objectives - After completing this session, learners will be able to:
- Explain how the movement of Earth's lithospheric plates causes both slow changes in Earth's surface (e.g., formation of mountains and ocean basins) and rapid ones (e.g., volcanic eruptions and earthquakes).
- Present evidence that supports the theory of plate tectonics, and explain the theory's importance to modern geology.
- Show how the rock cycle serves as a conceptual link between internal Earth processes that result in plate motion and surface processes involving biogeochemical cycling.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What are the fundamental internal and surface processes that explain Earth's ever-changing appearance, and how does the rock cycle connect these processes?***

Activities in this session delve into the evidence that supports the “big idea” in geoscience: plate tectonics. Learners also draw connections between Earth’s internal and surface processes by looking at the rock cycle.

Assignments in this session require learners to explain plate tectonics and how it has come to be called a unifying theory and to demonstrate an understanding of “scientific theory”. Learners also analyze and identify the mechanisms responsible for the creation of given landscape features.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 4: USING DATA SETS AND MAPPING TOOLS

Objectives - After completing this session, learners will be able to:

- Locate, manipulate, analyze, and interpret several large data sets about the Earth.
- Incorporate data sets and mapping exercises into an inquiry-based science lesson.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can mapping data help students explore Earth processes like plate tectonics and their connection to extreme Earth events, such as earthquakes?***

Activities in this session delve into an analysis of maps and data sets of extreme Earth events to further learners' understanding of plate tectonics.

Assignments in this session require learners to indicate their understanding of how tsunamis are generated and the relationship of these mechanisms to the existing geology and historic seismic activity of the California coast and to show an understanding that the intensity of an earthquake is a measure of its effects at different locations. Learners are also expected to articulate the interplay between plate tectonics and biogeochemical cycles on the surface of Earth that result in the rock cycle and to give examples of resources that would support the teaching of the linking of these concepts.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 5: EARTH'S HISTORY

Objectives - After completing this session, learners will be able to:

- Provide examples from different phases of the evolution of Earth systems that demonstrate the interactions of the biosphere, the atmosphere, the hydrosphere, and the lithosphere.
- Provide geological examples that demonstrate how the processes that shaped Earth in the past are the same processes that we observe today.
- Describe some of the tools that scientists use to determine the history of the evolution of life on Earth.
- Describe one or more approaches that you might apply to help students understand a large-scale phenomena such as deep time.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What is deep time, and how does the geological record help us understand the long history of the Earth system?***

Activities in this session delve into an examination of how the interaction of Earth's systems that shaped its expansive history can be seen in the geologic record. Learners also explore ways to help students understand large-scale phenomena such as deep time.

Assignments in this session require learners to describe the relationship between changing physical conditions on Earth and features of organisms from a particular geological time period and the differences and similarities between conditions in a chosen time period with those before and after. Learners are also expected to demonstrate a clear understanding of the difference between a hypothesis and a theory.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 6: BROAD TEMPORAL AND SPATIAL SCALES

Objectives - After completing this session, learners will be able to:

- Describe the location of Earth within the solar system.
- Describe how the relative position and movements of the Sun, Earth, and the Moon account for the seasons, observed moon phases, tides, and solar eclipses.
- Describe the relationship of our solar system to the Milky Way and the universe.
- Describe the leading hypothesis explaining the origin of the solar system between four and five billion years ago.
- Identify a number of specific teaching strategies to foster student comprehension of the vast scales associated with the solar system and universe.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can we help students understand how the Sun-Earth-Moon system affects our world?***

Activities in this session delve into the relationships among the Sun, Earth, and the Moon, and learners reflect on the origins and vast scales of our solar system.

Assignments in this session require learners to describe the Sun-Earth-Moon system using only observable phenomena while demonstrating an in-depth understanding of these phenomena. Learners also summarize their understanding of some of the pedagogic challenges associated with teaching students about space.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 7: WEATHER

Objectives - After completing this session, learners will be able to:

- Explain effects of pressure, temperature, moisture (including humidity, dew point, and precipitation), wind, and stability on daily weather.
- Identify major weather elements -- such as a cold front -- in time-series data and spatial data on a map.
- Describe both horizontal and vertical motions associated with mid-latitude weather systems.
- Explain why technological advances -- such as satellite remote sensing -- permit us to map and monitor changes in daily weather patterns.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What causes weather?***

Activities in this session focus on multiple visualizations and models to help learners analyze large weather systems and their effects on weather patterns. Learners also examine the major weather factors that influence daily weather.

Assignments in this session require learners to use what they have learned about the causes of weather phenomena to explain why the windward side of the mountain is usually cloudier and wetter than the leeward side. Learners also identify a concept related to weather events and describe an inquiry lesson plan to teach that topic using visualizations.
Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 8: CLIMATE CHANGE

Objectives - After completing this session, learners will be able to:

- Explain how radiant energy from the Sun creates temperature differences in water, land, and atmosphere -- which drive local, regional, and global patterns of atmospheric circulation.
- Describe how density differences in ocean water are responsible for ocean circulation.
- Explain the meaning and causes of the greenhouse effect and global warming.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What is climate and what evidence is there that human activity is inducing climate change?***

Activities in this session delve into an examination of Earth's climate history and learners consider how changes to the global climate can have major consequences for life on Earth.

Assignments in this session require learners to list three or four factors that affect climate and then explain how changes in these factors can lead to climate change. Learners are expected to identify several pieces of evidence for greenhouse warming and articulate an opinion of this evidence and its implications. Learners also complete their final assignment.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

Schedule

This course is scheduled to take approximately 45 hours to complete.

Requirements

Learners are expected to:

- Complete all assignments.
- Participate and actively engage in discussions with fellow learners while contributing to the social construction of knowledge.
- Be self-directed and self-motivated.
- Ask for assistance when they need it.

Facilitators are expected to:

- Provide feedback to all learners.
- Participate in discussions to keep them moving forward.
- Provide assistance to learners who need it.

Technical Requirements

- Word Processor
- Internet service provider
- E-mail
- Shockwave and Flash: http://www.macromedia.com/downloads/
- Acrobat Reader: http://www.adobe.com/products/acrobat/readstep.html
- QuickTime: http://www.apple.com/quicktime/download/

Standards of Academic Integrity
As posted on PBS TeacherLine Web site at
http://teacherline.pbs.org/teacherline/help/help_template3.cfm?subID=197

Evaluation
This course is evaluated on a letter grade basis, and graduate credit may be available. See the PBS TeacherLine Web site for details pertaining to specific graduate credit instructions.