EarthComm Professional Development Program - Curriculum Structure

Introduction

EarthComm is divided into five modules. Each EarthComm module has three chapters connected to each other by a common theme. Every chapter begins by asking questions about how various Earth science phenomena affect the student's community. Students develop answers to those questions by learning key ideas and understandings in the chapter activities. It is intended that the modules and chapters can be taught in any sequence. Teachers will need to consider the best sequence for their own students.
Modules and Chapters
I. Earth's Dynamic Geosphere
Volcanoes and Your Community
Earthquakes and Your Community
Plate Tectonics and Your Community

II. Understanding Your Environment
Bedrock Geology of Your Community
River Systems of Your Community
Land Use Planning in Your Community

III. Earth's Fluid Spheres
Oceans and Your Community
Severe Weather and Your Community
Cryosphere and Your Community

IV. Earth's Natural Resources
Energy Resources of Your Community
Mineral Resources and Your Community
Water Resources and Your Community

V. Earth System Evolution
Astronomy and Your Community
Climate Change and Your Community
Changing Life in Your Community

Just as teachers need to determine which chapters are best to use, workshop presenters will want to decide on the chapters and/or activities that would be best to use with their participants. Because of the excitement students feel about volcanoes, that chapter in the Dynamic Geosphere module is seen by many as a good starting place, and is used in this workshop guide to provide examples of key concepts in EarthComm. Following that, and depending on the time available, additional chapters may be done. In the one-day schedule that is provided, "Water Resources and Your Community" is used in the afternoon. In the weeklong schedule,

participants move quickly through all of the remaining chapters. For workshops with limited time, local considerations will influence those choices.

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5-E Learning Cycle Model

Each Chapter follows the 5-E lesson model: engage, explore, explain, elaborate, evaluate. Trowbridge & Bybee (1990) present the 5-E learning cycle in Becoming A Secondary School Science Teacher as an effective instructional model that is consistent with a constructivist approach to learning. In the model students encounter phenomena experientially (engage, explore) prior to having general rules stated that help them articulate underlying principles (explain.) Then, the skills and new knowledge are transferred to new situations (elaborate) and/or have their understanding enriched through additional experience. Student readiness to make meaning of additional experience is assessed (evaluation) before the cycle begins again. The component of the chapter that relates to each stage of the 5-E learning cycle is below:

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Curriculum Design

EarthComm modules have three chapters connected to a common theme. Every chapter begins with a community-based problem or issue that can only be solved by developing key ideas and understandings in the chapter activities. Activities follow a learning cycle model.

Component of EarthComm	What Happens in the classroom	Stages of 5-E Learning Cycle
CHAPTER CHALLENGE	Students read and discuss a scenario that presents a community-based issue to solve through Earth science and inquiry. They also explore the criteria and expectations for solving the challenge. Teachers allow students to share their current thinking openly and without closure.	Engage
1. Think About It	Students answer an open-ended question (or two) that sets the context for an activity and provides the teacher with a pre-assessment of their ideas. At times, students might be observing and responding to a teacher demonstration. They briefly discuss their ideas in groups and/or as a class. Teachers allow students to share their ideas openly. They avoid assigning formal labels to concepts or seeking closure.	Engage
2. Investigate	Students collaborate on an inquiry activity that requires hands-on work, literature or web research, or fieldwork. Teachers facilitate and guide student-driven inquiry.	Explore
3. Reflecting on the Activity and the Challenge	Students read a brief summary of the main ideas explored in the investigation and their relationship to the challenge. Teachers review the main ideas with students and affirm the relevance of the activity to the challenge.	Explain
4. Digging Deeper	Students read text, illustrations and photographs that explain concepts explored in the investigation. Terms are defined and clarified. Teachers provide further information and clarification of concepts through lecture, slides, videos, or laser disk presentations.	Explain
5. Check Your Understanding	Students respond to several questions related to the primary content goals of the reading (Digging Deeper). They re-read the material when they encounter difficulty answering these questions. Teachers review student responses and encourage students to revisit the reading when they have difficulty explaining the main points in their own words, either verbally or in writing.	Explain
6. Applying What You Have Learned	Students respond to questions that check their understanding of key principles and concepts (learning goals) for the activity. New, yet familiar situations and scenarios provide contexts for students to apply their developing understandings. Teachers review student responses and use the questions to further probe and hone understanding of key learning goals.	Elaborate

7. Preparing for the Chapter Challenge	Students put their investigative results into the context of the challenge by preparing or organizing their work as it relates to their final product. Teachers review student performance in terms of its consistency with criteria set forth in the expectations for the activity and the challenge.	Elaborate/ Evaluate
8. Inquiring Further	Students are presented with options for deepening their understanding of concepts and skills developed within the activity. Teachers promote and encourage further inquiry.	Elaborate/ Evaluate
CHAPTER ASSESSMENT	Students present their solution to the chapter challenge in a variety of formats and consider ways to share their findings beyond the classroom. Teachers use the challenge expectations to assess the extent to which student work demonstrates mastery of concepts and skills. They also explore creative ways to share student solutions with the community.	Evaluate
ALTERNATIVE ASSESSMENT	Students respond to a chapter test of essential knowledge and skills targeted throughout the chapter and developed by the teacher. Teachers score and review the test with students. They help students to understand how to use the results to guide future efforts.	Evaluate

EarthComm curriculum development was guided by ten fundamental ideas that are emphasized in all modules, and are the primary goals for student learning. It is important to take the time to go over these in a workshop. One approach to doing this is to have the teachers make a list of their own broad goals, as they see them, for Earth science instruction, and then compare them with these "big ideas." Experience shows that the lists generally compare favorably, with major differences usually coming about as a result of some goals being stated in more specific terms than these. In that case, the "big ideas" that the goals fit within are usually readily apparent.

EarthComm "Big Ideas"

1. Earth science literacy empowers us to understand our environment, make wise decisions that affect quality of life, and manage resources, environments, and hazards.
2. Earth's dynamic equilibrium system contains subsystems from atoms to planetary spheres. Materials interact among these subsystems due to natural forces and energy that flows from sources inside and outside of the planet. These interactions, changes, forces and flows tend to occur in offsetting directions and amounts. Materials tend to flow in chains, cycles, and webs that tend toward equilibrium states in which energy is distributed as uniformly as possible. The net result is a state of balanced change or dynamic equilibrium, a condition that appears to have existed for billions of years.
3. Change through time produced Earth, the net result of constancy, gradual changes, and episodic changes over human, geological, and astronomical scales of time and space.
4. Extraterrestrial influences upon Earth include extraterrestrial energy, materials, and influences due to Earth's position and motion as a subsystem of an evolving solar system, galaxy, and universe.
5. The dynamic geosphere includes a rocky exterior upon which ecosystems and human communities developed and a partially molten interior with convection circulation that generates the magnetosphere and drives plate tectonics. It contains resources that sustain life, causes natural hazards that may threaten life, and affects all of Earth's other geospheres.
6. Fluid spheres within the Earth system include the hydrosphere, atmosphere, and cryosphere, which interact and flow to produce ever-changing weather, climate, glaciers, seascapes, and water resources. These affect human communities, shape the land, transfer Earth materials and energy, and change surface environments and ecosystems.
7. Dynamic environments and ecosystems are produced by the interaction of all the geospheres at the Earth's surface, and include many different environments, ecosystems, and communities that affect one another and change through time.
8. Earth resources include the nonrenewable and renewable supplies of energy, and mineral and water resources. Individuals and communities depend upon these resources in order to maintain quality of life and economic prosperity.
9. Natural hazards associated with Earth processes and events include drought, floods, storms, volcanic activity, earthquakes, and climate change. They pose risks to humans, their property, and communities. Earth science is used to study, predict, and mitigate natural hazards so that we can assess risks, plan wisely, and acclimate to the effects of natural hazards.
10. In order to sustain the presence and quality of human life, humans and communities must understand their dependency on Earth resources and environments, realize how they influence Earth systems, appreciate Earth's carrying capacity, manage and conserve nonrenewable resources and environments, develop alternate sources of energy and materials needed for

human sustenance, and invent new technologies.

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Assessment Issues: General Approach

Assessment is one of the key areas of classroom teaching that participants ask about when trying to envision implementing EarthComm. In any curriculum model, the mode of instruction and the mode of assessment are connected. In the best scheme, instruction and assessment are aligned in both content and process. However, to the extent that one becomes an impediment to reform of the other, they can also be uncoupled. EarthComm uses multiple assessment formats. Some are non-traditional and are consistent with reform movements in science education that EarthComm is designed to promote. Project-based assessment, for example, is built into every EarthComm "Chapter Challenge." At the same time, the developers acknowledge the need to support teachers whose classroom context does not allow them to depart completely from traditional assessment formats, such as paper and pencil tests.

EarthComm includes two primary forms of assessment. The most integral form of assessment is project-based and relies on the chapter projects that the students complete for each "Chapter Challenge". The second is a more traditional multiple-choice pre-/post-test that can be used as needed. To facilitate the use of the chapter reports as assessment devices, Teacher's Editions of EarthComm modules provide a general scoring rubric. In this use, a rubric is "an established set of criteria for scoring or rating student responses on assessment tasks where the response involves more than selecting an answer from a prescribed list" (Doran, Chan, & Tamir, 1998, p. 205). The rubrics provided in EarthComm focus on four main criteria areas: concepts & principles, terminology, additional research, and presentation. Scores for each criteria range from 1-5. Teachers can develop an overall score by combining scores for various criteria. The general nature of the rubrics affords teachers the flexibility of using them as guidelines for establishing more specific expectations. All expectations should be communicated to students.

Assessment Rubric from Field Test Edition: Volcanoes and Your Community

Meets the Standard of Excellence 5	Significant information is presented about all of the following: • Locations of volcanoes closest to your community • Evidence of past or recent volcanic activity • Volcanic hazards • How volcanoes change the atmosphere, hydrosphere, biosphere and/or geosphere All the information is accurate and appropriate. The writing is clear and interesting.
Approaches the Standard of Excellence 4	Significant information is presented about most of the following: • Locations of volcanoes closest to your community • Evidence of past or recent volcanic activity • Volcanic hazards • How volcanoes change the atmosphere, hydrosphere, biosphere and/or geosphere All the information is accurate and appropriate. The writing is clear and interesting.
Meets an Acceptable Standard 3	Significant information is presented about most of the following: • Locations of volcanoes closest to your community • Evidence of past or recent volcanic activity • Volcanic hazards • How volcanoes change the atmosphere, hydrosphere, biosphere and/or geosphere Most of the information is accurate and appropriate. The writing is clear and interesting.

Below Acceptable Standard 2	Limited information is presented about the following: • Locations of volcanoes closest to your community • Evidence of past or recent volcanic activity • Volcanic hazards • How volcanoes change the atmosphere, hydrosphere, biosphere and/or geosphere Most of the information is accurate and appropriate. Generally, the writing does not hold the reader's attention.
Basic Level: 1	Limited information is presented about the following: • Locations of volcanoes closest to your community • Evidence of past or recent volcanic activity • Volcanic hazards • How volcanoes change the atmosphere, hydrosphere, biosphere and/or geosphere Little of the information is accurate and appropriate. The writing is difficult to follow.

In keeping with the discussion of assessment in the National Science Education Standards (NSES), care must be taken in developing the specific expectations for each chapter. Four issues are of particular importance in that they may present somewhat new considerations for teachers and students:

Integrative Thinking-The National Science Education Standards (NSES) state: "Assessments must be consistent with the decisions they are designed to inform." This means that as a prerequisite to establishing expectations, teachers should consider the use of assessment information. In EarthComm, students must be able to articulate the connection between Earth science concepts and their own community. This means that they have to integrate traditional Earth science content with knowledge of their surroundings. It is likely that this kind of integration will be new to students, and that they will require some practice at accomplishing it. Assessment in one chapter can inform how the next chapter is approached so that the ability to apply Earth science concepts to local situations is enhanced on an ongoing basis.

Importance- An explicit focus of NSES is to promote a shift to deeper instruction on a smaller set of core science concepts and principles. Assessment can support or undermine that intent. It can support it by raising the priority of in-depth treatment of concepts, such as students evaluating the relevance of core concepts to their communities. Assessment can undermine a deep treatment of concepts by encouraging students to parrot back large bodies of knowledge-level facts that are not related to any specific context in particular. In short, by focusing on a few concepts and principles, deemed to be of particularly fundamental importance, assessment can help to overcome a bias toward superficial learning. For example, assessment of terminology that emphasizes deeper understanding of science is that which focuses on the use of terminology as a tool for communicating important ideas. Knowledge of terminology is not an end in itself. Teachers must be watchful that the focus remains on terminology in use, rather than on rote recall of definitions. This is an area that some students will find unusual if their prior science instruction has led them to rely largely on memorization skills for success.

Flexibility-Students differ in many ways. Assessment that calls on students to give thoughtful responses must allow for those differences. Some students will find the open-ended character of the EarthComm chapter reports disquieting. They may ask many questions to try to find out exactly what the finished product should look like. Teachers will have to give a consistent and repeated message to those students, expressed in many different ways, that the ambiguity inherent in the open-ended character of the assessments is an opportunity for students to show what they know in a way that makes sense to them. This also allows for the assessments to be adapted to students with differing abilities and proficiencies.

Consistency-While the chapter reports are intended to be flexible, they are also intended to be consistent with the manner in which instruction happens, and the kinds of inferences that are going to be made about students' learning on the basis of them. The EarthComm design is such that students have the opportunity to learn new material in a way that places it in context. Consistent with that, the chapter reports also call for the new material to be expressed in context. Traditional tests are less likely to allow this kind of expression, and are more likely to be inconsistent with the manner of teaching that EarthComm is designed to promote. Likewise, in that EarthComm is meant to help students relate Earth science to their community, teachers will be using the chapter reports as the basis for inferences regarding the students' abilities to do that. The design of the chapter reports is intended to facilitate such inferences.

An assessment instrument can imply but not determine its own best use. This means that EarthComm teachers can inadvertently assess chapter reports in ways that work against integrative thinking, a focus on important ideas, flexibility in approach, and

consistency between assessment and the inferences made from that assessment. This is why it will be important to work through assessment issues with workshop participants. This manual contains sample student work that you can copy for participants to practice applying the non-traditional assessment methods used in EarthComm.

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