Part II: Engaging Learners

All About Digital Earth Watch—Part II: Engaging Learners—Chapter 7

Investigations, Activities, and Challenges

OK, so we have all these images from cameras hand-held or mounted on satellites, kites, balloons, tripods or you-name-it.   And we have this software to analyze the images with. What do we do now?

The supreme goal of Digital Earth Watch is to get people involved in doing science, monitoring the local, regional, or global environment, and raising awareness of how beautiful and complex are the systems that our planet has. This can be by people devising their own investigations for pursuit. On the DEW website we give some examples to show some of the types of things that can be done with images and image analysis software.

So what are the differences between the terms *Investigations*, *Activities*, and *Challenges*? In some ways, distinction is arbitrary or semantic. In DEW, we use the term ***Activities*** as an all-encompassing term that applies to both *Investigations* and *Challenges* so we put both *Investigations* and *Challenges* under *Activities* in the DEW left navigation bar. We use the term *Challenges* for relatively short activities that easily fit into one class period or less. *Investigations* are longer, more complicated activities, or series of challenges that may extend beyond one class period.

In the three subsequent sections there are descriptions of larger scale projects that provide opportunities for student investigations: Picture Post, Forest Watch, and Global Systems Science (GSS).

The table below summarizes the Challenges and Investigations that can be found on the DEW website.

__/'_/'_/'__

Challenges (require DEW software)

***This Challenge uses** ColorBasics:*

- Three Color Challenge—with the "Make Colors" function of ColorBasics software, you guess what a color is given only the percent red, green, and blue that are in that color.

***These Challenges require** DigitalImageBasics:*

- 1 Circle from 3 — In a Venn diagram, 3 circles each of red, blue, and yellow, you must change the colors of diagram so **one** *yellow* circle is displayed on a completely black background.
- A Cat's True Colors — You must change the colors of a picture of a cat to find the cat's true colors.

***These Challenges use** AnalyzingDigitalImages:*

- Disappearing Sea—You analyze the images of the Aral Sea to calculate the rate at which it is disappearing.
- Do Plants Grow At Night?—Using 4 successive images of a tray of Wisconsin Fastplanets, you find out how the rate of growth at night compares to what is observed during the day.
- Leaf Area—Compare the surface areas of three leaves.
- Pine Needle Length—Find the average length of pine needle from a sample of needles from a particular tree.
- Tree Canopy Density—Calculate the change in the percent leaf cover of a maple tree as it greens up in the spring.
- Tree Diameter—Compare the diameter at breast height (DBH) of two trees.
- Tree Height—Compare the height of a tree with the height of a telephone pole.

__/'_/'_/'__

Investigations

Explore Colors

- Dueling Light Beams—Use two overhead projectors (or slide projectors) and filters to combine colors of light.
- Compare Colors—compare colors produced by mixing colored light with colors produced by mixing pigments/paint (uses *ColorBasics* software).
- Naming Colors—guess what % values of red, green, and blue make up some common colors, then make up your own colors and name them (uses *ColorBasics* software).
- Tri-Color Prediction—(Three Color Challenge):

Digital Images

- Pixel Count—gradually increase the number of pixels in a "mystery" image, increasing the *resolution* until you can make out what the picture is (uses *DigitalImageBasics* software).
- The Color of a Pixel—use *DigitalImageBasics* software to look at the red, green, and blue intensities of a large pixel and compare that with

given % values of red, green, and blue, predict what color they make (uses *ColorBasics* software).

- Play with Colors—a fun game that pits your skill at identifying the red, green, and blue contributions in randomly generated colors against a friend or the computer (uses *ColorBasics* software).
- Make Colors Reference Chart—use data collected in the Naming Color and Tri-Color Prediction Investigations to make a r-g-b color color reference chart .
- Test Yourself—test your skill at "Play With Colors" game: get a quantitative assessment of your performance at matching 10 randomly generated colors.

the average of intensity values found for smaller pixels that define the same region

- The Color of the Sky—a look at color layers in images of the sky.
- Who Are You More Alike? Use digital photographs to measure faces to see who you look more alike.
- Near Infrared and You—Use special digital cameras to see why some clothes heat up more than others of the same color when exposed to sunlight.

Light

- Visually Exploring LEDs
- Lighting LEDs
- Measure the Angle of Sensitivity of an LED
- Measure the Range of Light an LED Detects
- Measure Emission, Transmission, Reflection & Absorption
- Measure Warm and Cold Objects with LEDs
- Measure the Reflection of Land Covers

These LED explorations were based on the work of Forrest Mims whose website, http://forrestmims.org/ can give you a richer content on the science behind LEDs.

Plants

- Adopt a Leaf
- Adopt a Branch
- Adopt a Landscape with PicturePosts
- What's Been in Your Backyard over the Past Centuries?
- Where Did Old Growth Forests Go?
- Studying an Urban Wetland

Science and Technology Standards

There are numerous educational standards that Digital Earth Watch can support.
We list here only a few, with the expectation that as the development of Next Generation Standards in 2012 will trigger a more exacting correlation of DEW with standards.

International Technology and Engineering Educators Association (ITEEA)

Standards for Technological Literacy

1. Students will develop an understanding of the characteristics and scope of technology.
2. Students will develop an understanding of the core concepts of technology.
3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
5. Students will develop an understanding of the effects of technology on the environment.
6. Students will develop an understanding of the role of society in the development and use of technology.

17. Students will develop an understanding of and be able to select and use information and communication technologies.

__/'_/'_/'__

National Science Education Standards

GRADES 5-8

Understandings about Scientific Inquiry

- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations. (p. 148)

Physical Science -- Transfer of Energy

- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object— emitted by or scattered from it—must enter the eye. (p. 155)

Life Sciences

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures,and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate,limit the growth of populations in specific niches in the ecosystem. (p. 158)

Earth Sciences

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat. (p. 160)

Science and Technology

- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis. (p. 166)

__/'_/'_/'__

Science in Personal and Social Perspectives

- Causes of environmental degradation
- and resource depletion vary from region to region and from country to country. (p. 168)
- Human activities also can induce hazards through resource acquisition,urban growth,land-use decisions, and waste disposal. Such activities can accelerate many natural changes. (p. 168)
- Societal challenges often inspire questions for scientific research, and social priorities often influence research priori- ties through the availability of funding for research. (p. 169)
- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs,attitudes, and values influence the direction of technological development. (p. 169)

GRADES 9-12

Physical Science - Interactions of Energy and Matter

- Waves, including sound and seismic waves,waves on water, and light waves, have energy and can transfer energy when they interact with matter. (p. 180)
- Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance. (p. 180-181)

Life Science

- Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.(p. 186)

- Human beings live within the world’s ecosystems. Increasingly, humans modi- fy ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected. (p. 186)

__/'_/'_/'__

Earth Science

- Heating of earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. (p. 189)
- Global climate is determined by energy transfer from the sun at and near the earth’s surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth’s rotation, and static conditions such as the position of mountain ranges and oceans. (p. 189)

Science and Technology

- Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt, and fulfill human aspirations. (p. 192)

Science in Personal and Social perspectives——Environmental Quality

- Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans. (p. 198)
- Materials from human societies affect both physical and chemical cycles of the earth. (p. 198)
- Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views , and different ways humans view the earth. (p. 198)

__/'_/'_/'__

National Council of the Teachers of Mathematics

Math Standards and Expectations

Number and Operations

Understand numbers, ways of representing numbers,
relationships among numbers, and number systems
Grades 6–8 Expectations: students should–
work flexibly with fractions, decimals, and percents to solve problems;
understand and use ratios and proportions to represent quantitative relationships;

Compute fluently and make reasonable estimates
Grades 6–8 Expectations: students should–
develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.

Algebra

Understand patterns, relations, and functions
Grades 6–8 Expectations: students should–
represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
Grades 9–12 Expectations: students should–
interpret representations of functions of two variables

Use mathematical models to represent and understand quantitative relationships
Grades 6–8 Expectations: students should–
model and solve contextualized problems using various representations, such as graphs, tables, and equations.
Grades 9–12 Expectations: students should–
draw reasonable conclusions about a situation being modeled.

Analyze change in various contexts
Grades 6–8 Expectations: students should–
use graphs to analyze the nature of changes in quantities in linear relationships.
Grades 9–12 Expectations: students should–
approximate and interpret rates of change from graphical and numerical data.

__/'_/'_/'__

Geometry Standard

Specify locations and describe spatial relationships using coordinate geometry and other representational systems
Grades 6–8 Expectations: students should–
use coordinate geometry to represent and examine the properties of geometric shapes;
Grades 9–12 Expectations: all students should–
use Cartesian coordinates and other coordinate systems, such as navigational, polar, or spherical systems, to analyze geometric situations;

Use visualization, spatial reasoning, and geometric modeling to solve problems
Grades 6–8 Expectations: students should–
recognize and apply geometric ideas and relationships in

areas outside the mathematics classroom, such as art, science, and everyday life.
Grades 9–12 Expectations: students should–
use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest such as art and architecture.

Measurement Standard
Understand measurable attributes of objects and the units, systems, and processes of measurement
Grades 6–8 Expectations:students should–
understand both metric and customary systems of measurement;
understand relationships among units and convert from one unit to another within the same system;
understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume.
Grades 9–12 Expectations: students should–
make decisions about units and scales that are appropriate for problem situations involving measurement
Apply appropriate techniques, tools, and formulas to determine measurements.
Grades 6–8 Expectations: students should–
select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels of precision;
develop and use formulas to determine the circumference of circles and the area of triangles, parallelograms, trapezoids, and circles and develop strategies to find the area of more-complex shapes;
solve problems involving scale factors, using ratio and proportion;
Grades 9–12 Expectations: students should–
analyze precision, accuracy, and approximate error in measurement situations;
apply informal concepts of successive approximation, upper and lower bounds, and limit in measurement situations;

__/'_/'_/'__

Data Analysis and Probability
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
Grades 6–8 Expectations: students should–
formulate questions, design studies, and collect data about a characteristic shared by two populations or different characteristics within one population;
select, create, and use appropriate graphical representations of data, including histograms, box plots, and scatterplots.
Grades 9–12 Expectations: students should–
understand histograms, parallel box plots, and scatterplots and use them to display data;
Select and use appropriate statistical methods to analyze data
Grades 6–8 Expectations: students should–
discuss and understand the correspondence between data sets and their graphical representations,
especially histograms, stem-and-leaf plots, box plots, and scatterplots.

Develop and evaluate inferences and predictions that are based on data

Grades 6–8 Expectations: students should–

use observations about differences between two or more samples to make conjectures about the populations from which the samples were taken;

make conjectures about possible relationships between two characteristics of a sample on the basis of scatterplots of the data and approximate lines of fit;

use conjectures to formulate new questions and plan new studies to answer them.

Process Standards

Problem Solving

Instructional programs from prekindergarten through grade 12 should enable all students to—

Build new mathematical knowledge through problem solving

Solve problems that arise in mathematics and in other contexts

Apply and adapt a variety of appropriate strategies to solve problems

Monitor and reflect on the process of mathematical problem solving

Communication

Instructional programs from prekindergarten through grade 12 should enable all students to—

Organize and consolidate their mathematical thinking through communication

Communicate their mathematical thinking coherently and clearly to peers, teachers, and others

Analyze and evaluate the mathematical thinking and strategies of others;

Use the language of mathematics to express mathematical ideas precisely.

Connections

Instructional programs from prekindergarten through grade 12 should enable all students to—

Recognize and use connections among mathematical ideas

Recognize and apply mathematics in contexts outside of mathematics

Representation

Instructional programs from prekindergarten through grade 12 should enable all students to—

Create and use representations to organize, record, and communicate mathematical ideas

Select, apply, and translate among mathematical representations to solve problems

Use representations to model and interpret physical, social, and mathematical phenomena