## LEO EnviroSci Inquiry: Making a Vision into a Reality

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#### Abstract

This paper describes the LEO (Lehigh Earth Observatory) EnviroSci Inquiry Website (http://www.leo.lehigh.edu/envirosci/) that provide K-12 teachers and students with technology-based materials to learn environmental science. This paper presents an overview of the Website and describes how it has been designed to meet the needs of diverse learners.

Recent reform documents, including the National Science Education Standards (NRC, 1996) and the National Geography Standards (GESP, 1994), emphasize the importance of teaching environmental science in K-12 classrooms and incorporating instructional technology into curricular contexts. Furthermore, the National Educational Technology Standards for Teachers (NETS, 2000) encourage educators to "implement curriculum plans that include methods and strategies for applying technology to maximize student learning." In response to these initiatives, many states, including Pennsylvania are developing academic standards that describe what students should know and be able to do in the areas of environment and ecology (PDE, 2000). We developed an extensive Website, called LEO (Lehigh Earth Observatory) EnviroSci Inquiry (http://www.leo.lehigh.edu/envirosci/), to provide K-12 teachers and students with technology-based materials to learn environmental science. This article presents an overview of the Website and describes how it has been designed to meet the needs of diverse learners.

Current research theory and best practices have guided the development of LEO EnviroSci Inquiry. Environmental science education learning activities should be inquiry-based and developmentally appropriate for learners. Activities should be interdisciplinary. Environmental education experiences should be based on the local ecological region of the learner as well as global contexts. Furthermore, environmental education must contain appropriate experiences in natural and human-impacted environments.

Environmental education experiences cannot be achieved solely within the confines of the regular classroom. Some experiences need to take place in the students' urban community, including city parks, school yards, sewage treatment plants, etc., as well as truly natural outdoor sites away from the city. Today's K-12 students do not generally have rich experiences investigating their local environment, whether it is in their city or a natural area. Many school systems do not have adequate resources to transport students to study their local areas. The

World Wide Web can provide ways for learners to explore remote geographic locations to which they would otherwise not have access to.

## **Description of the Website**

LEO EnviroSci Inquiry is indexed into five interconnected areas:

Lehigh River Watershed Explorations, Environmental Issues, Geology, Weather, and Data Collection Activities. Curricular activities actively engage learners in data collection, analyzing data, working with Web-based Global Information Systems (GIS) databases, and learning in interdisciplinary contexts. The Website enables classroom teachers to implement science teaching strategies that incorporate Web-based and other technologies into the classroom. Curricular activities emphasize student-directed scientific discovery of their local environment.

### Lehigh River Watershed Explorations

The main goal of Lehigh River Watershed Explorations area

(http://www.leo.lehigh.edu/envirosci/watershed/curricular/) is to present science to K-12 learners in a historical perspective by engaging them in a detailed study of the Lehigh River watershed. This watershed has a very rich history that presents learners with a unique opportunity to observe how the American industrial revolution has impacted a watershed over time. Stories are presented in the *History of the Lehigh Watershed* section that enable learners to explore science from a historical perspective and to observe how science and technology may impact society over time.

The *Lehigh River Watershed Photojournal* provides learners with the opportunity to virtually explore the Lehigh River watershed. The photojournal contains MPEG movie watershed flybys that provide the learner with a graphical overview of the topography of the area. GPS (Global Positioning) coordinates index the photojournal. In addition to digital images of the area, the photojournal Web pages contain short MPEG video clips and QuickTime Virtual Reality panoramas that allow learners to zoom in on specific physical features.

The *Water Quality* section contains background information and protocols that assist learners using Vernier CBL (Calculator-Based Laboratory) units and graphing calculators to collect water quality data. Data reporting forms are provided on the Website that enable learners to submit collected data to the LEO water quality database. This data can then be compared to other water quality data located on the Website. Web-based data links to the Lehigh River's USGS (US Geologic Survey) monitoring stations provide river flow data and real-time discharge data.

The *GIS* (Geographical Information Systems) section contains a variety of interactive maps of the Lehigh watershed. GIS mapping provides a spatial framework for analyzing environmental data such as water quality data and relating it to the characteristics of the land around it. Unlike static maps (such as the road maps you get at the gas station), GIS not only lets you view a map, but also lets you query the map for information that is not displayed. Figure 1 is an example of a land use map from the watershed.

The *River Explorations* and *Curricular Activities* sections provide innovative inquiry-based water quality and watershed studies activities developed by our research group and partner organizations.

#### Environmental Issues

The Environmental Issues area (http://www.leo.lehigh.edu/envirosci/enviroissue/) contains links to Science-Technology-Society (STS) issues-based approach simulations developed by our research group and partner organizations. These simulations provide learners with the experience of learning science and technology in the context of human experience involving real-life controversial issues. Engaging in an authentic issues makes environmental science instruction current and part of the real world. In these simulations, learners investigate a real-world controversial issue from different perspectives. After they complete their investigation, a public forum or debate is conducted to determine the next course of action on the issue. Classroom debates on STS issues offer learners a forum to think critically about the role that science plays in societal issues. These simulations acknowledge the connection between science and the decisions individuals make about social issues.

*The Shell Island Dilemma* is one example in this section. The scenario of the dilemma is that the Shell Island Resort is in danger of being destroyed by a migrating inlet. Mason's Inlet is moving south rapidly. The Shell Island Resort is currently situated in an Inlet Hazard Zone and is in dire straits. The objective is to investigate the issues concerning the fate of the Shell Island Resort and then to debate the future of this and other oceanfront structures threatened by coastal erosion. As learners engage in the investigation, they must identify the social, political and scientific issues with which different stakeholders must deal. The learners are placed into the role of one of the stakeholders. Web-based materials are provided for student research.

#### Weather

The Weather area (http://www.leo.lehigh.edu/envirosci/weather/) contains two distinct curricular resources for learners to explore weather phenomena. The first resource, Phenomenal Weather Explorations, is a series of guided Web-based Explorations of unique weather phenomena designed for learners in grades 4-8. In these explorations, students learn the science of hurricanes, tornadoes, lightning, and the Green House effect. The second resource, Bits of Biomes, provides a learning environment that uses a guided inquiry-based approach for learners to investigate characteristics of biomes including climatic differences, populations, and ecosystems in terrestrial biomes. In *Bits of Biomes*, learners investigate the driving question: "Do selected cities in our study really exhibit the characteristic climatic conditions of their defined biome?" Learners work in groups to collect climatic data on selected cities that characterize different biomes. They use spreadsheets to explore patterns in their climatic data. Climatic data in different biomes are compared. The groups research characteristics of a particular biome that includes people and culture, animal life (vertebrates and invertebrates), plant life, and economic conditions. Each group contributes a section to a class "World Travel Book." The "World Travel Book" can be a class Web site, a hypermedia artifact, or a traditional paper artifact. Throughout the implementation of the unit, students participate in hands-on

experiments that focus their learning on topics that include habitats, predator/prey relationships, adaptations to environments, and food chains.

#### Geology

The Geology area (http://www.leo.lehigh.edu/envirosci/geology/) contains interactivities for learners to use virtual reality in their science investigations. "Which Way Is North?" is an activity that allows learners to develop skills in understanding location by exploring a variety of unique geological formations using QuickTime Virtual Reality (QTVR) panoramas and topographic maps (Figure 2). "Dino Inquiry" allows learners to explore a variety of dinosaur fossil bones from the Dinosaur National Monument quarry using panoramas and digital still imagery. "Geologic Explorations" allows one to explore a variety of unique geological formations through the use of QTVR.

#### **Data Collection Activities**

The Data Collection Activities area (http://www.leo.lehigh.edu/envirosci/data/) connects learners to a variety of earth and environmental science data sets and collection activities currently underway at LEO (Lehigh Earth Observatory). The LEO WeatherNet is an electronic network of weather and water monitoring stations. Learners can access real-time and archived weather data from weather and water monitoring stations near the Lehigh University Campus and from lake monitoring stations on the Pocono Plateau. The LEO hydroprobe area contains a database of water quality data taken from a hydroprobe located on the lower reaches of the Lehigh River. The probe measures a variety of water quality parameters and is logged on an hourly basis. Classroom learners use this data to examine temporal patterns of the health of the river. The LEO Seismic Station area contains data from a broadband seismic station located on South Mountain at Lehigh University. Data collected from the seismic station provides information on active seismicity in northeastern Pennsylvania. This station is a part of the Northeastern Regional Seismic Network, which monitors earthquake activity in the eastern U.S. In addition to learning about earthquakes, learners can link to the GSN (Global Seismic Network) maintained and operated jointly by IRIS (Incorporated Research Institutes in Seismology) and the US Geological Survey. The Salamander Response to Climate Change project (SRCC) focuses on the use of salamanders as a natural indicator of changes in environmental conditions. Learners can access current research being conducted in Northeast Pennsylvania at South Mountain, Hawk Mountain, and the Lacawac Sanctuary to examine salamander activity in relation to environmental conditions. Environmental data, recorded on data loggers in the field, can be compared with salamander activity levels to predict salamander response to climate change.

#### Meeting the Needs of Diverse Learners

Primary and secondary learners with different levels of ability can use LEO EnviroSci Inquiry as an instructional tool to learn environmental science concepts. To meet the needs of diverse teaching and learning styles, LEO EnviroSci Inquiry provides many different types of activities ranging from very structured guided inquiry investigations to open-ended activities where students generate their own questions for investigations. We recognize that one instructional

model does not accommodate every learner, classroom teacher's pedagogical style, or classroom learning environment. The Website's primary function is to serve as a resource for an in-depth study of the Lehigh River watershed. However, many learning activities are designed to be used by learners who reside in other geographical locations.

The Website's Educator's Guide (http://www.leo.lehigh.edu/envirosci/guide/index.html) provides instructional strategies for incorporating the Web-enhanced activities into the classroom. Tables 1 and 2 describe specific teaching suggestions for incorporating LEO EnviroSci Inquiry into primary and secondary science curricula.

## Conclusions

We have been brainstorming and developing activities for LEO EnviroSci Inquiry for the past two years. We are now in the evaluation phase of the project, testing to see what students are learning by using this Web-based environment. We have observed elementary and secondary teachers pilot test materials in their classrooms during the past school year. Teachers have implemented the LEO Web-based activities in a variety of instructional settings including demonstrations in a one-computer classroom settings, learning centers in a six computer classroom, and in a computer lab where each learner has their own computer. We have observed that limited access to networked computers in some classrooms is still a barrier to students to being successful in using technology to enhance their learning. We continue to work with classroom teachers to improve on the design and development of the LEO EnviroSci Inquiry activities. It is our intent to continue to provide a Web-based environment designed to enhance student learning of environmental science by integrating instructional technology into curricular contexts.

### References

Geography Education Standards Project. (1994). Geography for Life: National Geography Standards 1994. Washington, DC: National Geographic Society.

ISTE NETS Project (2000). ISTE NETS performance profiles for preparing tomorrow's teachers to use technology [Online document]. Eugene, OR: International Society for Technology in Education. Available: http://cnets.iste.org/TeacherStandards.html

National Research Council. (1996). National Science Education Standards. Washington, DC: National Academy Press.

Pennsylvania Department of Education. (2000). Proposed Academic Standards for Environment and Ecology. Harrisburg, PA. [Online document]. Available: http://www.pde.psu.edu/standard/ecology.pdf

Table 1. Selected primary school teaching suggestions for incorporating the LEO EnviroSci Inquiry Web site into science curricula.

• Have students explore the Lehigh River Watershed Photojournal. Guide students in the comparison of the physical characteristics of the different regions of the river.

Use the following guiding questions to engage students:

How is the river different at the headwaters areas compared to areas where the river approaches the Easton?

What types of animals would you expect to find living in these areas? Why do you think that? What things do you observe that are "man made" in the watershed? Do you think these things are good for the environment or harmful?

• Have students learn about hurricanes, tornadoes, lightning, and the greenhouse effect using a series of guided inquiry Web-based Explorations of unique weather phenomena in the Phenomenal Weather Explorations section. After the students have explored this Web-based activity, have them compare these unique natural phenomena. Have students write science journals that tell a story about living through a severe weather storm.

• Have students record daily climatic data in their school yard for the entire school year. Have students graph their data and then analyze their data for patterns. Student data can then be compared to the weather station data from the LEO WeatherNet stations.

• Have students explore interactive GIS maps from the Lehigh River watershed on the Web.

• Have students look at historical photographs of the Lehigh River watershed and then compare these photographs to current ones.

• Have students explore the QuickTime Virtual Reality panoramas and digital images of the dinosaur fossil bones at the Dinosaur National Monument quarry in Dino Inquiry. Have students examine the characteristics of the dinosaur fossils. Have students predict a bone's function based on their structural observations of the dinosaur fossils.

• Have students explore different geological features that are present in the 360 degree QuickTime panoramas and digital photographs in Geologic Explorations. Have students compare these geologic features to geologic features outside their classroom window. Use guiding questions to encourage students to think about similarities and differences. Have students predict what types of animals they would expect to live in each location featured on the Web site. Table 2. Selected secondary school teaching suggestions for incorporating the LEO EnviroSci Inquiry Web site into science curricula.

• Have students monitor the water quality of a nearby river or tributary over the course of the school year. Students can record data, analyze the water quality of their local watershed, and create a database of their information. The Water Quality Background section of the Web site contains information on different chemical parameters. The Water Quality Data Collection Procedures section contains protocols for data collection. Students can compare their water quality data with those in different regions of the Lehigh River watershed and other US watersheds in the Water Quality Data Links section. A variety of different watershed curricular units, activities, and links to investigational computational lab tools are available in the Curricular Activities section of the Web site.

• Have students explore the Lehigh River Watershed Photojournal. Have students create a data chart that they can use to compare the physical characteristics of the different regions of the river. Have students examine their data chart for similarities and differences within the watershed areas. As an extension to this activity, students can examine flow rate patterns in the different areas of the watershed using the real-time and archived Lehigh River Watershed USGS data.

• Have students create their own questions about the Lehigh River watershed to investigate. Have students explore interactive GIS maps from the Lehigh River watershed and other data collected from the LEO hydroprobes, weather stations, and seismic stations to assist in their investigations.

• Have students explore the History of the Lehigh River Watershed. Instruct students to create "a day in the life story" that explores how science has influenced technological development in the watershed.

• Have students compare the Lehigh River watershed with the Neuse River watershed. Use guiding questions to focus students' investigations to compare man-made influences in these watersheds, describe how industrial development has changed these watersheds, and note other changes that have occurred over time.

• Have students use an open-ended inquiry approach to investigate a fish kill. Fish Kills is an activity that provides students the opportunity to formulate their own research questions, explore and locate information, assess their findings, and present their information.

• Have students use topographic maps and QuickTime VR panoramas to determine map orientations by examining physical features in Which Way Is North?

• Have students plot different physical features on a map using the digital images, QuickTime VR, and GPS positions provided in Geologic Explorations.

• Have students use the Bits of Biomes activity to investigate characteristics of different biomes. In this activity, students explore climatic differences, populations, and ecosystems in terrestrial biomes. Students collect climatic data on selected cities within each biome. They use spreadsheets to explore their patterns in their climatic data. Climatic data in different biomes are compared. Student groups research characteristics of their biome. These include people and culture, animal life (vertebrates and invertebrates), plant life, and economic conditions. Each student group contributes a section to a class "World Travel Book." The "World Travel Book" can be a class Web site, a hypermedia artifact, or a traditional paper artifact.

• Have students use Phenomenal Weather Explorations to guide their inquiry into unique weather phenomena such hurricanes, tornadoes, lightning, and the greenhouse effect.

• Use the Internet to locate photographs of other watershed areas in the world and compare these to the Lehigh River watershed. Focus on the presence and absence of "man made" structures. How do these impact the environment?



Figure 1. Land Use GIS map. Graphic courtesy of LEO. Copyright 2001, Lehigh University.

Figure 2. Web page from Which Way Is North? Graphic courtesy of Alec M. Bodzin. Copyright 2000, Alec M. Bodzin.

