SCALE Project Profile

Overview

The purpose of this profile is to help us to generate a shared framework for comparing the design process and curricular product from different research and development groups. We ask you to describe your own water quality-related curriculum and also to reflect on the process of designing effective curricular materials. We will review and summarize responses from all participating projects prior to the workshop, and use your answers as a starting place for thinking about how we can work together to generate a shared curriculum that would have value for all of us.

Not all research groups will find all of these categories meaningful (or relevant). However, this represents a best attempt to provide a framing that allows each group to provide information about how they go about their work.

Instructions

Please complete as many of the sections of the profile as are relevant to your project. Please email the completed profile, along with any related files (e.g. assessment instruments, lesson plans, student artifacts) to Eric Baumgartner (ebaum@socrates.berkeley.edu) by September 14, 2001.

It's important that we receive a copy of this profile from you, even if in draft form, prior to the workshop. Further, the assessment team (Ken and Britte) really wants to start looking at assessment instruments prior to the workshop, so please send any assessment measures that you can. (Contact Britte at bcheng@socrates.berkeley.edu if you aren't sure exactly what assessments to send.)

The text in blue marks placeholders for your answers. Just edit this file and send it, along with any relevant assessment instruments, to Eric once you're done.

Thanks!

Eric, Marcia, and Jon

Project title: LEO EnviroSci Inquiry

1. Abstract

Please provide a short (200 word) description of the curriculum. Feel free to reuse existing descriptive text if possible.

The LEO EnviroSci Inquiry Web site is a K-12 outreach project from LEO - the Lehigh Earth Observatory and the SERVIT (Science Education Research in Visual Instructional Technologies) Group in the College of Education at Lehigh University. EnviroSci Inquiry enables teachers, students, and the public to learn about environmental science content knowledge from Lehigh University LEO scientists and interns. Learning activities actively engage participants in data collection, analyzing data, working with Global Information Systems (GIS) databases, and engaging in science-specific pedagogical practices that incorporate Web-based and other technologies to be implemented into the science classrooms. Environmental science curricular activities enable students to use Calculator-based laboratory (CBL) probeware, Web-based telecommunication tools, QuickTime Virtual Reality (QTVR), and other Internet resources to learn about environmental issues. Curricular activities emphasize student-directed scientific discovery of their local environment aligned to the National Science Education Standards, National Educational Technology Standards, and the National Geography Standards.

The key goals of the LEO EnviroSci Inquiry are:

- Actively engage K-12 students in authentic scientific inquiry that will enhance existing classroom curricula.
- Enable K-12 students to learn scientific content, concepts, and processes by integrating a variety of instructional technologies into science curricular contexts.
- Create an innovative Web-facilitated project linking together research scientists, university students, science educators, inservice teachers, preservice teachers, and students to translate current scientific knowledge and practices into teaching practices.
- Enhance the professional development of inservice and preservice teachers to develop new skills and gain a new level of confidence that empowers them to become effective leaders and advocates for science education.

2. Goals and Standards

2.1 Benchmarks

Identify any specific state or national science standards or benchmarks that your curriculum is designed to meet. Note that we will use the AAAS benchmarks in discussions at the workshop itself. These are online at <http://www.project2061.org/tools/benchol/bolframe.htm>.

Project Benchmarks:

Grades K-2

The Nature of Science

- People can often learn about things around them by just observing carefully.
- In doing science, it is often helpful to work with a team and to share findings with others

The Physical Setting

- Some events in nature have a repeating pattern.

The Mathematical World

- Similar patterns may show up in many places in nature and in the things people make.

Common Themes

- Things change in some ways and stay the same in some ways.

Habits of Mind

- Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out.
- Use numerical data in describing and comparing objects and events.
- Ask “How do you know?” in appropriate situations and attempt reasonable answers when others ask them the same question.

Grades 3-5

The Living Environment

- A great variety of living things can be sorted into groups in many ways using various features to decide which things belong to which group.
- Features used for grouping depend on the purpose of the grouping.

The Designed World

- Through science and technology, a wide variety of materials that do not appear in nature at all have become available, ranging from steel to nylon to liquid crystals.
- Discarded products contribute to the problem of waste disposal.

The Mathematical World

- Tables and graphs can show how values of one quantity are related to values of another.

Common Themes

- Things change in steady, repetitive, or irregular ways-or sometimes in more than one way at the same time. Often the best way to tell which kinds of change are happening is to make a table or graph of measurements.
- Some features of things stay the same even when other features change.

Habits of Mind

- Offer reasons for their findings and consider reasons suggested by others.
- Use numerical data in describing and comparing objects and events.
- Buttress their statements with facts found in books, articles, and databases, and identify the sources used and expect others to do the same.

Grades 6-8

The Physical Setting

- Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life. Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life.

The Living Environment

- Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce.
- All organisms, including the human species, are part of and depend on two interconnected food webs.

The Mathematical World

- Graphs can show a variety of possible relationships between two variables.
- Some shapes have special properties
- Some shapes have special properties

Habits of Mind

- Organize information in simple tables and graphs and identify relationships they reveal.
- Read simple tables and graphs produced by others and describe in words what they show.
- Locate information in reference books, back issues of newspapers and magazines, compact disks, and computer databases.

Grades 9-12

The Nature of Science

- Scientists can bring information, insights, and analytical skills to bear on matters of public concern.

The Mathematical World

- Tables, graphs, and symbols are alternative ways of representing data and relationships that can be translated from one to another.
- Different ways to map a curved surface onto a flat surface have different advantages.

Common Themes

- Things can change in detail but remain the same in general
- Graphs and equations are useful ways for depicting and analyzing patterns of change.
- In many physical, biological, and social systems, changes in one direction tend to produce opposing influences, leading to repetitive cycles of behavior.

Habits of Mind

- Use computer spreadsheet, graphing, and database programs to assist in quantitative analysis.
- Learn quickly the proper use of new instruments by following instructions in manuals or by taking instructions from an experience user.
- Use computers for producing tables and graphs and for making spreadsheet calculations.
- Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
- Suggest alternative ways of explaining data
- Check graphs to see that they do not misrepresent results by using inappropriate scales or by failing to specify the axes clearly.
- Use tables, charts, and graphs in making arguments and claims in oral and written presentations.

2.2 Cognitive learning goals

Describe any cognitive learning goals, related to science content or inquiry, that are not reflected in the benchmarks above.

Project learning goals for existing activities…

- Learners use a variety of visual instructional technologies (Web-based GIS, virtual photojournal, data charts and graphs) to identify relationships among environmental factors in the Lehigh River watershed (*Lehigh River Watershed Explorations*).

- Learners investigate a real-world controversial issue from differing perspectives (*Fish Kills!, Shell Island Dilemma).*

- Learners participate in a public forum or debate to determine the next course of action of a science-technology-society (STS) issue (*Shell Island Dilemma*).

- Learners will acknowledge the connection between science and the decisions individuals make about social issues (*Fish Kills!*, *Shell Island Dilemma*).

3. Nature of the curriculum

3.1. Curricular format

Is your curriculum paper-based? Web-based? How do you “package” your curriculum? Are there any financial costs associated with running the curriculum?

The LEO EnviroSci Website project is a Web-based instructional system that has been designed to be “customizable” by the individual user. 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.

The financial costs associated with running the project include operational costs for server maintenance, maintaining data collection equipment (Vernier probes, GPS, hydroprobes, weather stations, seismographs, etc.), support for graduate students to serve as quality control for student data collection, and curricular development costs.

3.2 Technological components

Describe any technologies used by the curriculum and their intended purpose.

Technologies used include...

- Web-based 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.
- Web-based data reporting forms. Allow learners to send field observations and recorded data to a cumulative database.
- CBL systems, TI-83 Plus graphing calculator, and Vernier data collection probes. Technology-based tools used for site-based data collection.
- LEO hydroprobe. Web-based searchable interface that contains a database of water quality data taken from a hydroprobe on the lower reaches of the Lehigh River. The probe measures temperature, pH, specific conductance-resistivity, salinity-TDS, dissolved oxygen, and redox potential. LEO interns operate and maintain the probe, organize the data, which is logged on an hourly basis, and analyze the results for a segment of the Lehigh River near Bethlehem.
- LEO WeatherNet. An electronic network of weather and water monitoring stations. Learners can access current and archived weather data from weather and water monitoring stations near the Lehigh University Campus and from lake monitoring stations on the Pocono Plateau.
- LEO Seismic Station. Contains data from a broadband seismic station on South Mountain at Lehigh University. Data collected from the seismic station provides information on active seismicity in northeastern Pennsylvania, including the Lancaster Seismic Zone and the Reading

Earthquake Sequence. This station is a part of the Northeastern Regional Seismic Network, which monitors earthquake activity in the eastern U.S.

3.3 Activity structure

Describe the activity structure of the curriculum. This could include a lesson plan, an outline of the different activities, or examples of the actual materials. Explain how the activities within the curriculum form a coherent whole.

Activity structures vary depending on the target audience of each learning activity. Many activities are interdisciplinary in nature and based on the local ecological region of the learner as well as global contexts. Many curricular activities emphasize student-directed scientific discovery of their local environment.

Fish Kills! (http://www.leo.lehigh.edu/envirosci/watershed/riverexp/fishkills.html) is an open-ended inquiry activity designed for secondary school learners. This activity gives students the opportunity to formulate their own research questions explore and locate information, assess their findings, and present their information.

The *Water Quality* (http://www.leo.lehigh.edu/envirosci/watershed/wq/index.html) 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 *Environmental Issues* area (http://www.leo.lehigh.edu/envirosci/enviroissue/) contains 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. 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.

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.

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.

4. Curricular customization

All of us design, and redesign, curricular materials, but we don’t often talk about the process of redesign and how we build on initial successes and failures to continually improve our materials. This section asks you to reflect on the process of designing, and redesigning, curriculum.

4.1 Setting

Describe the typical classroom setting for your curriculum in terms of grade level, subject matter, period length, curriculum length, etc.

Typical classroom settings vary across primary and secondary school settings and include diverse student learning populations. Our research group works with a variety of different classroom teachers who operate under different curricular constraints and resources within their school districts. Our partner classroom teachers have used the LEO EnviroSci 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. Limited access to networked computers is an existing barrier to some of the classrooms that use the materials.

4.2 History

When was the curriculum first designed and used?

Initial curricular activities have been under development by the SERVIT group since 1998. These activities, including *Water What-Ifs* and *Carolina Coastal Science* are now partnered projects with LEO EnviroSci Inquiry. The development of the existing LEO EnviroSci Website began during summer 2000 with support internally from Lehigh University and a Keck foundation grant. Activities were pilot tested during the 2000-2001 academic school year by elementary, middle and high school classrooms.

4.3 Evolution and iteration

How many times has the curriculum been redesigned? What were the significant changes (in the activity structure, in the learning goals, in the classroom setting, etc.) in each of these iterations? What prompted those changes?

Currently, we are developing WBI (Web-based inquiry) activities using the LEO water quality and GIS archived and real-time data sets.

4.4 Examples of curricular change

Some changes are larger than others, but not everyone agrees about which changes are major and which changes are minor. Please give an example of what you would consider a major change that occurred during redesign and an example of what you would consider a minor change.

Section non-applicable.

4.5 Justifying change

What kinds of evidence do you use to motivate and justify changes to the curriculum? Do certain kinds of evidence (e.g. teacher feedback, available classroom time, qualitative or quantitative data from classroom research studies, researcher or developer impressions from being in the classroom, etc.) carry greater weight in the redesign process? Is different evidence required to justify different kinds (e.g. major vs. minor) of change? Why?

We employ a user-centered design strategy that focused simultaneously on interface issues, students and teachers' subjective experiences in using Web-based interactivities, and student learning outcomes. Our mixed method formative evaluation combined experimental methods and qualitative approaches to assess prototype materials in terms of their ease of use, pedagogy, program performance, and clarity and depth of content.

A battery of methods and instruments are used to provide us with feedback to inform our development decisions during our redesign process during the formative evaluation of the materials. These include:

- Content knowledge assessments. Pre and posttest student assessments.
- Usability analyses. We focus on determining whether or not the interfaces are consistent and easy to use (user evaluation) and determining whether or not the program performed as specified (functional evaluation).
- Site-based field observations.
- Attitude measures. Teachers and classroom student participants complete a post-implementation survey consisting of Likert-type and open-ended questions after using materials in their classroom
- Student response journals. A sample of students are asked to write a student reaction paper about their experience.
- Interviews with teachers and students.

4.6 Curricular strengths and weaknesses

Given what you know now, what are the key strengths of your curriculum? Where is there room for improvement?

Strengths	**Weaknesses**
Project supports graduate students to serve as quality control for student field-based data collection. This ensures that scientists can use the data.	Materials are Web-based. Inequitable for classrooms without network access. However, most instructional materials can run locally on a CD-ROM. This provides access for learners in classrooms with computers that do not have network connections.
Web-based materials provide learners with the ability to "view environmental science" on a temporal scale.	More learner-centered curricular materials need to be developed for the Website.
Use of Web-based GIS to allow learners to use visual data for pattern seeking and data queries. Provides for the integration of NETS and National Geography standards.	A "structured curriculum" has not yet been completed. This is currently under development.
Website contains a variety of different activity structures ranging from open-ended to highly structured.	The Website is extensive.
Website is designed for learners of all ages to use.	
Website provides learners access to a variety of archived, real-time, and near-real time watershed data that use visual instructional technologies that include GIS, virtual photojournals, and graphs. Enables learners that may have inadequate access to field-based sites access to watershed data.	

5. Designing for customization

5.1 Customization potential

We want to understand how your curriculum supports customization by teachers or other researchers. What aspects — technological support, activity structure, goals, materials, etc. — of your curriculum are critical (e.g. removing or changing some elements would make the curriculum ineffective)?

The critical aspects of our curriculum include providing a diverse set of activities for teachers to select from based on their comfort level with inquiry. Materials range from highly structured guided information synthesis activities (*Exploring the Neuse River Basin*) to open-ended inquiry-based activities that provide scaffolding to model an inquiry process (*Fish Kills!).*

What aspects of your curriculum are amenable to adaptation?

The flexible aspects of our curriculum include..

- The use of data collection tools for gathering evidence (see water quality data collection forms and protocols).
- Using many Web-based activities with different age levels of students. See *Educator's Guide* for examples.

5.2 Design framework

Describe the design framework used within your research group. What are the major guiding principles that inform your curricular development process?

In a constructivist Web-based instructional system, learning is based on students' active participation in problem-solving and critical thinking regarding a learning activity that they find relevant and engaging. The student's role is active, not passive in this setting.

Many activities have been developed using a modified Dick and Carey instructional model that is augmented with constructivist components:

1. Determine Instructional Goal
2. Analyze the Instructional Goal
3. Analyze Learners and Contexts

4. Write Performance Objectives
5. Develop Assessment Instruments
6. Develop Instructional Strategy
7. Develop and Select Instruction
8. Design and Conduct Formative Evaluation of Instruction / Revise Instruction
9. Conduct Summative Evaluation

Constructivist Elements:

The following elements are incorporated into the Dick and Carey model to create a constructivist environment within the instructional system:

- Learning occurs with the context of an authentic learning environment in which students use real information and make decisions in a learning environment.
- Learning occurs within the context of a social experience.
- Learners are provided an experience from multiple perspectives.
- Learners are provided with experience in a knowledge construction process.
- Learners are aware of their knowledge construction process.

Design considerations used in Website development:

- Keep it simple.
- Identify your audience.
- Identify the size screen your audience will view the Website on.
- Identify the type of Internet connectivity the audience will have.
- Accommodate special populations of students that will use the Web site.
- Use design attributes to let the user know that they are in your Website. Use consistent background, layout and navigation links throughout the entire Website.

5.3 Design process

Describe the design process used within your research group. Who participates in the design process, and at what stage? How frequently do you iterate? What kinds of evidence and warrants lead to design changes? How do you make (and document) design decisions?

Our design process begins with a needs assessment conducted jointly between the development team and the target users (classroom teachers). After storyboarding occurs, a rapid prototype is usually designed. A focus group is conducted with the target users. Recommendations are made and modifications occur. A prototype is developed. Target users provide the development team with feedback. Recommendations are made and modifications occur. The prototype is pilot tested in a classroom. Participant observations are conducted. An iterative feedback cycle continues between the target users and the development team. Field testing occurs. A mixed method formative evaluation approach is used to assess prototype materials in terms of their ease of use, pedagogy, program performance, and clarity and depth of content.

6. Assessment and Research

Include any citations that address these issues. *Please include with this profile any assessment instruments that you use with the curriculum.*

6.1 Student artifacts

What are the major student artifacts that are produced in this curriculum? How are they assessed?

- In *Bits of Biomes*, 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.

- In *Fish Kills!*, learners represent their findings with a report and a presentation.

- In the *Shell Island Dilemma*, learners complete a “Position Statement Handout “during their investigation. A “Student Record Sheet Assessment” is provided for each individual student to complete at the conclusion of the debate.

6.2.Assessment measures

What other assessment measures are used (by the teacher or the researcher) in the project? What is the purpose of these assessments?

The primary assessment measures include pre and post content assessments, teacher and student attitude questionnaires, small group student interviews, and teacher focus groups.

6.3. Findings

Summarize (or cite) any research findings that have emerged from your work.

No current findings to report at this time. LEO EnviroSci materials are currently being pilot tested with middle school teachers.