

# **The Role of Educative Curriculum Materials in Science Teacher Professional Development**

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## **Abstract**

Educative curriculum materials are designed to promote teacher pedagogical content knowledge in addition to student learning. The use of educative curriculum materials in and of themselves provide a form of professional development since they include designs to promote teacher learning and support teacher decision-making for implementing curriculum materials. In designing such materials, science curriculum developers recommend providing baseline instructional guidance for teachers, and implementation and adaptation guidance. Educative curriculum materials provide rationales for instructional decisions. If teachers understand the rationale behind a particular instructional recommendation, they may be more likely to enact the curriculum in keeping with the developers' intent.

Educative curriculum materials are curriculum materials designed to promote teacher pedagogical content knowledge in addition to student learning (Ball & Cohen, 1996). Davis and Krajcik (2005) recommend the following "high-level" guidelines for developing such materials:

- Educative curriculum materials can help teachers learn how to anticipate and interpret what learners may think about or do in response to instructional activities (Ball & Cohen, 1996; see also Collopy, 2003; Heaton, 2000; Remillard, 2000).
- Educative curriculum materials can support teachers' learning of subject matter (Ball & Cohen, 1996; see also Heaton, 2000; Schneider & Krajcik, 2002; Wang & Paine, 2003).
- Educative, curriculum materials can help teachers consider ways to relate units during the year.
- Educative curriculum materials can make curriculum developers' pedagogical judgments visible to teachers.
- Educative curriculum materials can promote a teacher's pedagogical design capacity, or his or her ability to use personal resources and the supports embedded in curriculum

materials (i.e., the curricular resources) to adapt curriculum to achieve productive instructional ends (Brown & Edelson, 2003)

### **Educative Curriculum Materials in ELI**

In designing educative curriculum materials, our *Environmental Literacy and Inquiry* (ELI) curriculum developers, researchers, and teacher partners recommend baseline instructional guidance for teachers, as well as implementation and adaptation guidance (Ball & Cohen, 1996; Davis and Krajcik, 2005). ELI is available online at: <http://ei.lehigh.edu/eli/>. We design instructional materials to anticipate and interpret what learners might think or do in response to a learning activity; and expand teachers' content knowledge and geospatial pedagogical content knowledge. Our educative curriculum materials also provide teachers with rationales for instructional decisions. Teachers are known to draw on their own resources and capacities to read, make meaning, evaluate and adapt curriculum materials to the needs of their students (Remillard, 2005). If teachers understand the rationale behind a particular instructional recommendation, they may be more likely to enact the curriculum in keeping with the developers' intent (Davis & Varma, 2008). We develop our instructional materials in such a way that makes the instructional design model visible to teachers. This design feature provides teachers with an understanding of the rationale to how materials are intended to be used with classroom learners.

Our materials are designed to promote teacher learning of spatial thinking skills that are geographic (see Gersmehl & Gersmehl, 2006) in addition to supporting teachers' learning of interdisciplinary earth and environmental science subject matter (Schneider & Krajcik, 2002). The instructional materials are designed to provide additional supports for teachers who work with diverse learners. They include learning tools that enable access to learner ideas and attitudes that students bring to the classroom (for example the use of concept maps and pre-assessments).

Teacher professional development is highly effective when designed to accompany particular curriculum materials. We contend that the use of educative curriculum materials in and of themselves provide a form of professional development since they include designs to promote teacher learning and support teacher decision-making for implementing curriculum materials. These materials may be used independently or with other forums for teacher learning such as face-to-face or Web-based professional development experiences. Remillard (2000) describes using curricular materials to “speak to” teachers about rationales behind instructional decisions. Since the classroom teacher is the agent who ultimately decides and structures what is to be taught educative curriculum materials should help teachers to understand how Google Earth fits contextually within the instructional design of the curriculum. For example, in both the *Land Use Change* and *Energy* curricula, Google Earth is used to explore concepts through geospatial-supported investigations. Consequently, our instructional materials are designed to help teachers learn how image displays in Google Earth, when used with overlay features such as terrain, roads, and 3-D buildings in urban areas, provide support for students to identify and interpret land-cover features.

Educative curricular materials can be used to help teachers promote spatial thinking skills. When using Google Earth to promote spatial thinking skills, there is a need for explicit instruction in spatial analysis to help diverse learners understand visual representations in remotely sensed images. Much structure is needed to guide students to observe spatial patterns in land use, especially in areas that are unfamiliar to them. Furthermore, unlike adults who have developed better locational skills as automobile drivers, middle school student typically have a myopic view of their world, so spatial locations are more difficult for them to comprehend. Our Google Earth activities allow learners to view their world close up as they normally encounter it and to pan back to see relationships between things they only know previously in isolation. In our curriculum materials, we provide instructional recommendations encouraging teachers to model the processes of analyzing and interpreting such relationships to their students. In addition, we design educative curricular materials to help teachers provide appropriate scaffolds

to students when they examine images with different land use types, especially in areas that include environmental contexts that are unfamiliar to students.

**Select Examples:**

1. Instructional framework graphics.

Each figure at the top of each instructional sequence page informs teachers about which instructional design model components a particular day’s instruction aligns to. For example, Figure 1 taken from <http://ei.lehigh.edu/eli/energy/sequence/day8.html> denotes that the day’s activity will involve an **Explore and Investigate** activity and a **Modify Instruction** activity. In this solar energy activity, students use My World GIS to analyze annual average sunshine data to determine good locations for solar plants. Students investigate sunshine patterns at locations of existing and proposed solar power plants. They analyze "newly planned" solar power plant locations in 2009 and determine optimal locations to build new very large solar power plants. As part of the instructional sequence, teachers are presented with the following text to ensure the students understand main concepts. If not, teachers are prompted to modify instruction accordingly:

*If students at the completion of the activity do not understand that ideal locations for large solar power plants include areas with a large annual average percent sunshine, modify instruction as needed to ensure students understand this concept.*

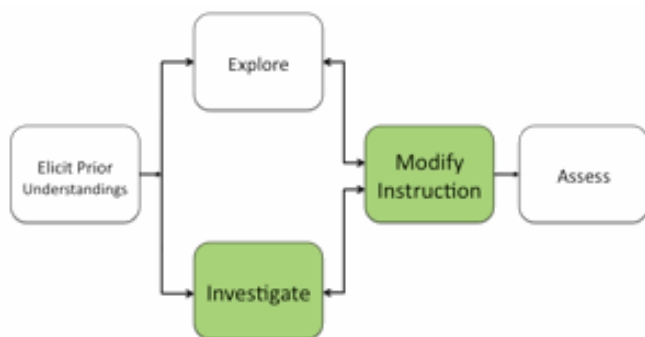


Figure 1. Instructional design model component graphic.

## 2. Pedagogical Supports

As noted earlier, we provide specific pedagogical supports to help teachers with making productive adaptations in their instruction. For example, in the Land Use Change unit, (<http://ei.lehigh.edu/eli/luc/sequence/day13.html>) we provide the following two items in the instructional sequence to assist teachers with supportive pedagogical decision-making:

*Certain populations of students have much difficulty interpreting remotely sensed images in environmental contexts that are unfamiliar to them. Much scaffolding and highly structured questions may be needed to guide students to observe spatial patterns in time-sequenced images that are associated with observing land use change over time in diverse geographical locations. If needed, modify instruction to model the processes of analyzing and interpreting these images to your students.*

*Prior to discussing **question 18**, introduce the term "**sprawl**" to students. Sprawl is defined as the process in which the spread of development across the landscape far outpaces population growth. In discussing student responses to question 18, emphasize the importance of "smart growth" practices that takes advantage of wise resource use including: encouraging compact building development and discouraging dispersed, automobile dependent development at the urban fringe; taking advantage of existing structures such as reusing abandoned industrial sites (brownfield development; building along rail lines and public transportation routes; and creating highly connected roads, sidewalks and paths, allowing relatively direct travel by motorized and nonmotorized modes. Note to students that satellite images can be used to identify landscape provisions for smart growth practices in rapidly growing cities.*

## 3. Content knowledge support

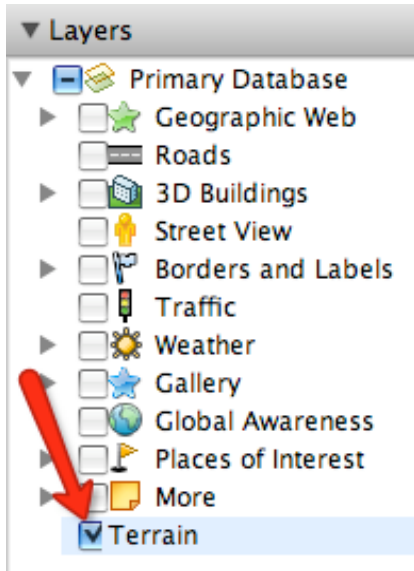
ELI materials contain instructional resources designed to promote teacher content knowledge support (<http://ei.lehigh.edu/eli/luc/support/>). Each support material is also provided via

hypertext link in each instructional sequence page. For example, on the first implementation day of the activity, *What's Hot at The Mall?*, (<http://ei.lehigh.edu/eli/luc/sequence/day5.html>) a content resource is provided to provide teachers with sufficient content background to understand how thermal images are used by scientists to understand how the heat is captured and then released by a city's buildings and pavement. This instructional resource provides additional information to introduce the concept of urban heat islands and its affects on the local environment.

#### 4. Geospatial tools support

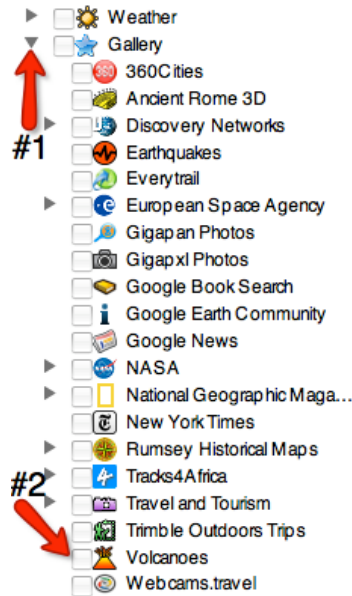
The *Teachers Guides* for the geospatial learning activities are designed to help teachers learn how to display images in Google Earth and MyWorld GIS to take advantage of various overlay features to display more idealized visualizations to promote learning. For example, the instructions below from *Where is the Best Place to Locate a Geothermal Power Plant? Teacher Guide* (<http://ei.lehigh.edu/eli/energy/sequence/day19.html>) provides information for teachers to select specific layers to provide an optimal visualization for students' explorations.

c. Check to make sure that only the box to the left of **Terrain** in the **Layers** window in the left panel has a checkmark (see arrow below).



d. Click the arrow to the left of **Gallery** in the **Layers** window in the left panel (see arrow #1 below).

Scroll down and check to make sure the box to the left of **Volcanoes** is **not** checked (see arrow #2 below).



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