Building a World

An online science learning environment motivates and teaches.

The World Builders site teaches science content and allows students to apply it by building their own world.

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One can see examples of bent and tilted layers in many places in the world. Sometimes the strata run straight up and down. Scientists learn about the age of the earth from studying these strata.

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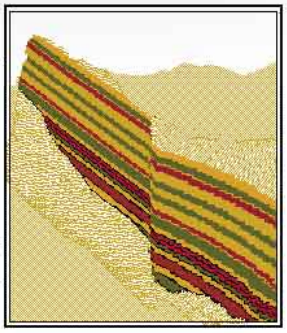

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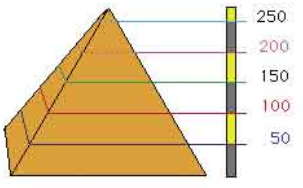
Like pages in a book, the stratified layers of rock hold information about the past of our planet and its life forms.

Step One

The first step is to decide on your measuring units. This pyramid is about 300 feet high. I have decided to measure it in 50 foot increments. By this I mean

color	Elevation of The Section
	between 250 ft and 300 feet
	between 200 ft and 250 feet
	between 150 ft and 200 feet
	between 100 ft and 150 feet
	Between 50 ft and 100 feet
	Between 0 ft and 50 feet



Notice that I have marked a measuring rod.

I use the measuring rod to find the elevations of different parts of the pyramid. I make dots all around the pyramid where the pyramid is 50 feet above the ground. When I have finished, I join the dots with a line. Next I make dots around the pyramid where it is 100 feet up from ground level and join that set of dots. I do this for each level. The lines that join the dots are called contour lines.

Note that we are not measuring up the slanted side of the pyramid. We are measuring the distance straight up from the ground.

By Elizabeth Anne Viau

Subject: Astronomy, geology, meteorology, biology, ecology

Audience: Teachers, teacher educators, library media specialists

Grade Level: 3–12 (Ages 8–18)

Technology: Web/Internet; Web page authoring, presentation, and word processing software; Acrobat

Standards: *NETS•S* 3 (http://www.iste.org/standards)

The tool of the future sits on my desk, but what lies behind that bright computer screen? Information floats on the surface, but that is not what I am after: I am a teacher, and I want to find a way to draw my students into an unforgettable learning adventure. What they need is a vision, an idea that will enlist motivation and initiate a serious hunger for information. I have an idea for them. Why not build a world?

The Web Site's Origins

Starting with this idea, I began to build a Web site. My students need an information-rich playground to learn in, with clearly delineated major concepts, focused assignments, plenty of choices, and opportunities to exercise creativity. They will need accessible material to begin to learn with and links to more advanced material and the expansion of the guiding ideas.

I began to put the site together and to start teaching the course at California State University, Los Angeles, to inservice teachers. As in any new class, my students showed me what was working and where new material was needed, and over the course of the last decade the Web site—World Builders—has expanded to about 500 pages of instructional material and 34 fictional planets created by groups of adult students, mostly teachers. The Web site now has lessons, science notes, hundreds of links, rubrics, hands-on activities, worksheets, tests, and diagrams. Although I use the site with my graduate inservice teachers, it is also being used, in whole or in part, in classrooms from third grade up in many content areas. Sometimes teachers use a single page in a lesson; sometimes they may do a unit or use part of the site to support a WebQuest or classroom assignments. One high school teacher wrote, "I would like to use some of your materials with my high school science fiction class. We will be writing science fiction stories, and I plan to use your Web site to help the students write a more developed and realistic story based in science fact." I also receive e-mail from home schoolers who are building worlds and from young students who have used my biome pages independently to do a homework assignment.

The Tool in Practice

When my working teachers take this class, they work in small groups (three students is ideal) and design planets that are in harmony with current science knowledge. They report on their planets and post the reports on the Web. A former student of mine said, "It wasn't until I was finished that I realized each Web site was like 'a book on a shelf' for future K–12 clasrooms to use to build their own worlds."

The idea of world building is simple, the reality complex beyond imagination, yet it is a "one size fits all" idea: anyone can play, from the kindergartner to the expert scientist. Each learner starts with his or her current knowledge and builds from there. Everybody learns, including the teacher.

The students begin by forming their groups and brainstorming. What kind of a planet do they want? Once the groups have come together, they begin to work on the actual units.

World Builders consists of 10 units, each one giving a taste of a different facet of science.

1. ***Astronomy: Locating Your Planet Near a Star***
   Here, students design their solar system, name their sun, planets and moons, and figure out the orbits and year lengths with the help of Kepler's Laws.
2. ***Geology: Forming the Rocky Surface***
   Students study some elementary geology, learn about tectonic plates, and make maps.
3. ***Meteorology: Air, Ocean, and Weather***
   Students rework topographical maps to show rainfall and temperatures on the planet, providing the opportunity for them to learn about the atmosphere and weather.
4. ***Microbiology: Unicellular Life and Ecology***
   Here, the students get their only miracle: they create life. They learn a little about microbiology, unicellular creatures, and cell division. They begin discussion about adaptation and evolution, and think about the many life forms on our planet that we cannot even see. Additional pages provide a simple look at basic genetics.
5. ***Marine Botany: Processes and Structures of Seaweed***
6. ***Marine Zoology: Processes and Structures of Animals***
7. ***Marine Ecology: Aquatic Communities***
   The fifth, sixth, and seventh units describe a water world: the stu-

However, when dealing with the big ideas of science, experimenting using the scientific method often does not capture the grandeur and magnificence of these amazing processes.

dents design seaweeds, animals, and small ecosystems for life forms that live in water. They show how the living organisms change from very simple creatures to more complex ones. They think about evolution, adaptation, and how living in water shapes life forms.

8. *Botany: Land Plants—Structure & Reproduction*

9. *Zoology: Land Animals—Structure & Reproduction*

10. *Land Ecology*

The eighth, ninth, and tenth units describe life forms on land, showing how plants and animals evolved from the species that live in the water. The students choose the temperature and rainfall conditions that affect their ecological systems and describe and illustrate individual biomes. They come to appreciate the formidable challenges that living on land poses, such as dehydration, the stresses caused by gravity, and exposure to higher concentrations of ultraviolet light. They also work with the concept of limits: only so much solar energy falls on a given piece of ground, and only some of this energy is used by the plants to build themselves. Animals eat the plants and each other, but the whole scheme rests on the capture of available energy, which is limited. Environmental issues involve the concept of limits, and it is useful to understand models that demonstrate sustainable resource use. Humans are not exempt from the limits that constrain the population growth of other species, and our students need to know this.

A Sample Unit

Let's look at how Unit 2 might be used in the classroom. It addresses six topics, which could be used together or individually:

- The Structure of the Earth: core, mantel, crust
- Tectonic Plates: rocky material circulates between the crust and the mantle
- How Different Types of Rocks Are Formed: igneous, sedimentary, metamorphic
- How Fossils Help Scientists to Date Rocks
- Erosion Shapes the Landscape: rivers, glaciers, wind
- Map Making: topographic maps (small map of school ground or nearby streets for younger learners)

Whenever possible, the learning and discussion should be supplemented by hands-on activities, which are included in the World Builders site. My adult students have found that doing these activities aids understanding to an extent that just reading about them does not, and I see a marked improvement in the quality of their work when they have had the hands-on experience.

I have included rubrics for Web pages and PowerPoint presentations. You could also have students write a short paper. The rubrics have evolved over time. Students find it helpful to have specific directions and a picture of what the final product could be like. Although their projects may be organized differently, they can check the requirements on the rubric to be sure they've produced a complete project.

Assessment

When doing one or two sections of the unit, making rubrics and grading can be directly related to the material taught and the hands-on activities. However, when doing larger sections of the course, grading and feedback can be very time consuming. I like to use Adobe Acrobat to grade my students' Web pages.

Each student makes a home page with links to all the pages for which he or she is responsible. Linking is possible within Word, PowerPoint, and on Web pages. The student turns in this page and any associated pages on disk or by e-mail.

Open the student's home page and all of the linked pages in Acrobat. Among Acrobat's tools there is a note tool. This creates electronic sticky notes. If you find errors in the student's work or want to add a comment or suggestion, click on the note tool and then on the student's text. The note tool immediately opens a small area in which you can type. These little notes can be moved around and closed by clicking on the square on the upper left corner.

After you have read and corrected the pages, save them as a PDF file and return it to the student by e-mail or on disk. The student can then open the pages in Acrobat Reader and follow your instructions. You retain a copy of the corrected file so that you can check the student's corrections on later drafts. As the pages are perfected, you can use the note tool to mark each completed assignment on the list on the student's home page. This ensures that both you and your students can easily determine which assignments have been completed and which need further attention. If you don't have access to Acrobat, you

could use Word's Track Changes feature to make notes for your students.

Feedback from Other Teachers

Letters from teachers indicate that they use the units on the site in a variety of ways. They may use a unit, or part of one, to help them organize a PowerPoint presentation, or they may select pages as a reading assignment for their students. They may have the students use the links pages to do some research on the Web. An Ohio teacher wrote, "I plan on using this Web site to teach asexual reproduction to 6th graders at my school in Ohio. … I plan on making my own unit using a PowerPoint presentation and will use this site as a direct link." Teachers may use a hands-on activity, take some items from the study questions for use in a test, or use the resources on the site as an information source for a WebQuest. One teacher and technology coordinator wrote, "We are a third-grade classroom preparing a poster for a science fair on the Earth's water. Your information was great and very understandable! Thank you!" Or, teachers may select one section, for example, map making, and have their classes work through it, using materials on the site to combine with their own lessons. If time and the standards permit, they may elect to have the class do a whole unit.

Using the materials on the site for teaching and study is conventional and, like much of the informational part of learning science, is mainly about absorbing facts and strengthening the learning with hands-on activities. However, when dealing with the big ideas of science, experimenting using the scientific method often does not capture the grandeur and magnificence of these amazing processes. This is where model building comes in, encouraging students to use their creativity and critical thinking together to apply what they have learned.

If time permits, let students design a world. Divide them into groups of two or three and let them map it out, figuring out where the deep sea trenches would be, where the mountains go, and where the rivers run. This assignment captures student interest, and involves critical thinking. Students should be able to give you reasons for features on their maps. The maps can be drawn, drawn and scanned, or created in a drawing program or with a map-making program such as Fractal Terrains.

The World Builders materials are constructivist, and they are structured to stimulate question generation, targeted information gathering, critical thinking, discussion, and problem solving. They encourage application, analysis, synthesis, and evaluation. Because personal creativity is involved, getting the information is important: each student wants to make a really good planet, in harmony with scientific principles, of course. The material to be covered should, of course, be modified to be appropriate to the grade level.

I started out wanting to lay out a sort of smorgasbord for the mind, a place where information would feed the imagination and leave the eater hungry for more. World builders will probably always be under construction, and, I hope, will become more useful and interesting as it grows. You and your students are invited to visit. Boldly go!

Resources

Fractal Terrains: http://www.profantasy.com
World Builders: http://curriculum.calstatela.edu/courses/builders/
Unit 2: http://curriculum.calstatela.edu/courses/builders/lessons/less/les2/0Vles2.html

Elizabeth Anne Viau is an emeritus professor at California State University, Los Angeles, where she continues to teach courses, including her award-winning World Builders course. She received her PhD from the University of Oregon in 1986 from the Computers in Education program. She is interested in innovative interdisciplinary teaching models.

Thank You!

ISTE members are wonderful and generous. The *L&L* staff would like to especially thank the members who volunteered time from their busy NECC 2003 schedules to meet with us. Look for members like this month's subjects, Paul Meldrum and Gary Brown, in the new member profile section each issue on p. 46.

We'd also like to express our gratitude to **ISTE 100 member Intel** and its Innovation in Education program for providing Intel digital microscopes as gifts for the participants.

If you'd like to volunteer to be the subject of a member profile, please contact us at **letters@iste.org.**