

## **Simulations in Science Courses for Non-science Majors**

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As a graduate student in geochemistry at the University of Washington in the 1970's, I found that my real interest in life was teaching introductory students. The faculty members at UW were supportive of this change in my direction and I was able to get a Ph.D. in a joint effort between the Geosciences Department and the College of Education. Part of my research involved assessing the spatial and mechanical reasoning aptitudes of introductory students and how these aptitudes interacted with different methods of instruction.

In 1993, I attended Project Update Geoscience, organized by the late Dottie Stout. At this meeting I was introduced to several computer-based simulations that I was able to use in my introductory geology classroom and lab. At this same meeting, Gary Novak (California State University- Los Angeles) demonstrated several science labs that are now available on the web. I use parts of his Virtual River lab frequently to help students understand how we determine the discharge of a local stream.

In 1999, Green River Community College (GRCC) received a CETP grant from NSF to prepare materials for a series of interdisciplinary science classes for non-science majors, including pre-service primary teachers. We developed a sequence of three Interdisciplinary Science courses (IDS). The cohort of students remains the same through the year, but we have a variety of science instructors from physics, chemistry, geology, and biology instructors that team-teach the class through the year.

To determine what we were going to teach in this IDS sequence, we polled the Science faculty at Green River and asked "What should students majoring in fields outside of science be able to do upon completion of their science requirement?" and "What should these same students know upon completion of their science requirements?" Although the list of skills and subject matter to be mastered was several pages long, there was a consistent opinion that these students should develop the ability to set up an experiment to answer a scientific question, interpret graphs, and develop confidence that they can answer scientific questions.

Since we wanted the students to gain skills in doing science, we decided that the fundamental approach of the course should be centered around of a series of guided-inquiry modules. If you are familiar with the work of Lillian McDermott (University of Washington) and her text, Physics by Inquiry, you will recognize the style of the class sessions.

We selected the overall theme of climate and global change to be the organizing thread for the three courses. The topics of the first quarter are measurement and basic physics

including several sections from Physics by Inquiry. The second quarter includes temperature, pressure, atmospheric science, climate change, and geological changes in the Earth over time. The third quarter contains biological and environmental science topics.

Computer simulations seem to be an effective means of helping students investigate some IDS concepts. One of my GRCC physics colleagues, Keith Clay, has used “Physlets” to construct several animations of elementary, but poorly understood concepts, such as intensity of light, why the earth has seasons, and the phases of the moon. Keith developed companion handouts to help guide the students through these simulations. Keith and I taught the class last winter and I am currently teaching the class with Mary Whitfield, from the chemistry department. The home page for the Interdisciplinary Science courses and links to the simulations used in some of our modules are referenced at the end of this essay.

We also use animations developed by other people in our modules. For example, we want our students to understand the role of trace gases in the atmosphere in influencing the Earth’s climate; this requires that the students learn about emission, absorption, and filtering of light. Our students visit a University of California-Berkeley site that permits them to mix colors of light in emission and absorption as well as try different filters.

It seems to us that interactive simulations are more effective than animations that simply run the same movie over and over. When the students can change variables and test ideas, they ask better questions and seem more interested in the process.

My goals related to visualization are to learn to develop interactive simulations and to write guided-inquiry modules to use in geology and Interdisciplinary Science courses.

General URL for the Interdisciplinary Science courses at Green River Community College:

<http://www.instruction.greenriver.edu/ids/>

Handout for Trace Gases in the Atmosphere module:

<http://www.instruction.greenriver.edu/ids/102/Modulesw04/TraceGases.pdf>

Simulations used in this module:

<http://mc2.cchem.berkeley.edu/Java/emission/Java%20Classes/emission.html>

<http://mc2.cchem.berkeley.edu/Java/absorption/Java%20Classes/absorption.html>

<http://mc2.cchem.berkeley.edu/Java/single/Java%20Classes/single.html>

Handout for Intensity of Light and Seasons on Earth module:

<http://www.instruction.greenriver.edu/ids/102/Modulesw04/IntensitySeasonsw04.pdf>

Simulations used in this module:

<http://www.instruction.greenriver.edu/physics/intensity/>

<http://www.instruction.greenriver.edu/physics/seasons/>

Handout for Phases of the Moon module:

<http://www.instruction.greenriver.edu/ids/102/Modulesw04/Phases%20of%20the%20Moonw04.pdf>

Simulations used in this module:

<http://www.instruction.greenriver.edu/physics/moon/>

Reference:

Filson, R., 1979, Instruction in college-level, introductory geology: Interactions of two teaching methods and selected student characteristics, unpublished Ph.D. dissertation University of Washington, 169 p.