**Sustainability: The Key To Student Engagement**

As an “Instructor of Interdisciplinary Science” at a community college that teaches numerous interdisciplinary, team-taught learning communities each year, I have had a lot of opportunity to explore teaching sustainability in a variety of contexts. The hugely interdisciplinary nature of sustainability offers a lot of opportunity for engaging activities and courses. I have worked throughout my career to incorporate concepts of sustainability into geoscience and chemistry courses, and am currently focusing on expanding the sustainability strand in all classes that address the natural world or science in a societal context (e.g. Physical Geology, Oceanography, Environmental Geology, Geology of the Pacific Northwest, Chemistry Concepts, and Eastern & Western WA Field Study).

Examples of interdisciplinary course I have taught that foster understanding of sustainability include:

*Pathways To Sustainability* (Chemistry Concepts & Global Issues): In this class we explore the scientific, social, economic and political aspects of problems associated with our cultures reliance on energy and food (e.g. air pollution, global climate change, ecosystem degradation, nuclear waste). The students engage in major group projects and presentations analyzing current and emerging sustainable practices in transportation, electricity generation & distribution, and food at local, regional, and global scales. A description of this course is posted as part of the *Curriculum for the Bioregion* curriculum collection on the SERC site, which will go public in late August.

*Earth Exposition* (Environmental Geology & English): When teaching environmental geology I strive to place geologic hazards and Earth resources in the context of human choices that are or are not sustainable from risk, resource use, and Earth System perspectives. For example, approximately the later third of the class is spent on a unit exploring the relationships among energy resources, mineral resources, waste management, and global climate change. Students read Elizabeth Kolbert’s book “*Field Notes From A Catastrophe*”, write a term paper on human response to climate change, and develop a group presentation (e.g. poster, slide show or web site) that synthesizes the findings of all group member’s essays. A description of this course will be part of this workshop course collection.

*Diving Into Oceanography* (Oceanography & English): This course has a similar format to *Earth Exposition* (above; i.e. writing intensive) but includes a major unit exploring the relationship between humans and the Salish Sea (a name applied to recognize that the Puget Sound (USA) and Strait of Georgia (CA) are one system). Students read *“State of the Sound 2009”*, and apply what they have learned in the class about the inter-relationships among the geo-, hydro-, bio-, and atmosphere to understanding how human activities impact the integrity of the Salish Sea system, and degrade its ability to provide essential ecosystem services.

Strategies I have used to foster interdisciplinary learning include: (1) the exploration of sustainable practices at various scales as described above for the *Pathways* learning community, (2) comparison of the nature of scientific explanations and the structure of academic theses and their support in essays in classes where science and English composition were linked, (3) reflective writing assignments asking students to compare and contrast the nature of geologic processes and ceramics techniques in a Geology and Ceramics learning community. Another important strategy is to find overarching concepts like *Systems* or *Energy* whose meaningful exploration requires multiple perspectives (e.g. Earth System approach in *Diving Into Oceanography* above).

The most important consideration is designing a course or activity from my perspective is to use findings from cognitive research (e.g. “*How People Learn”* <http://www.nap.edu/openbook.php?record_id=9457&page=10>) which shows that deep, enduring learning requires three components: (1) prior conceptions on a subject must be engaged in order for new learning to be integrated with existing knowledge, (2) students must build their own understanding of a concept/topic with hands-on activities, and (3) reflection on the learning process and specifically where their existing knowledge was challenged or changed is critical to long-term retention and the ability to apply new knowledge in different contexts. Consequently, it is critical that activities and courses as a whole provide students with as much opportunity as possible to record and discuss their initial ideas, to collect and interpret evidence, and engage in personal and group reflection on the significance of a particular activity or the overarching themes of a course as a whole.

The most significant challenge to realizing the benefits of interdisciplinary learning on the topic of sustainability, in my experience, is how to provide room in the course schedule to do a meaningful job of exploring the sustainability themes. For example, adding a sustainability strand to an Environmental Geology course means that there is less time to develop the traditional content of the course. Many geology and chemistry textbooks are, however, finding ways to weave in sustainability while minimizing the impact on traditionally important topics as well as exploring significant connections with aspects of sustainability. One example of this is the impact of population growth on the risk presented by geologic hazards (e.g. earthquakes, volcanism).

Exploring human choices that are- or are not sustainable from geologic hazard, resource use, and Earth System perspectives offer significant opportunity for integration of geoscience concepts with sustainability. Social science concepts like population dynamics, affluenza, and the cultural & political context of global climate change are clear areas where significant connections between scientific and other disciplines can be exploited. Examples I have used in various classes include:

• When teaching Chemistry Concepts, for which I use the “*Chemistry In Context: Applying Chemistry To Society*” textbook, I focus on energy, climate change, and their societal context. I spend considerable time developing the concepts that understanding the climatic response of past forcings (insights gained via the geosciences) is the key to climate forecasts, and that the alarm on the part of scientists to global climate change is evidence-based.

• In environmental geology, I have students read the introduction to “*Cradle-To-Cradle: Rethinking the Way We Make Things*” by McDonough & Braungart (North Point Press, 2002), view *The Story Of Electronics* (http://www.storyofstuff.org/movies-all/story-of-electronics/), and do a lab where they perform a life cycle analysis of the sources and fate of the materials in a cell phone. This exercise is modeled after and includes elements of “*Computer Chip Thermochemistry:* *How Can We Create an Integrated Circuit From Sand?*” from the *chemconnections* series.

• In many of my classes I have students keep a waste journal for a week and estimate how much waste they generate in a year, where it goes, and what land-use, climate, and mineral resource impacts/implications their habits have. I have posted a description of this activity (titled *Waste As A Resource*) as part of the *Curriculum for the Bioregion* curriculum collection on the SERC site, which will go public in late May or early June in time for the InteGrate workshop.

• During the energy resources unit of environmental geology, chemistry concepts, and my energy and society seminar, I have students work through the Carbon Mitigation Initiatives Stabilization Wedge Game (<http://cmi.princeton.edu/wedges/game.php>) and write personal responses on the impact of the scenario on their understanding of the societal context of our resource use choices.

• I am currently using climate change as a through-going thread in my Geology of the Pacific Northwest class. I had my students read “*A Human-induced Hothouse Climate*” by Kidder & Worsley in the February 2012 issue of GSA Today. I’m building on this perspective by looking at mechanisms driving climate change in the past (orbital, tectonic, biochemical, etc.) and how, as stated in Kidder & Worsely (2012), our current activities rival these forcings.

• Part of my on-going work with the *Chemistry For The Informed Citizen* grant (NSF-CCLI) (described below) as been to develop a module that uses an exploration of climate modeling as a means of promoting understanding of the use of models and modeling in the sciences. This module has students read about and use ice –core data to model (forecast) the role of CO2 in future climate change.

In conclusion, the geosciences offer abundant opportunity to engage students in meaningful interdisciplinary learning that has real relevance to their lives. In light of the status of sustainability as arguably the most important issue of the 21st century, it would be a disservice to our students not to find as many means as possible to foster its understanding.