

Emphasizing the Science in Geoscience

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Geoscience was not part of the curriculum when I went through the New Jersey public schools. Things have certainly improved since then: geoscience is now part of the New Jersey Core Curriculum Standards for public schools; it is covered in the High School Proficiency Assessment (HSPA) that students take junior year; there is an Advanced Placement (AP) exam in Environmental Science; and current hot topics of climate change, environmental sustainability and hydrofracking have brought new visibility to our discipline.

However, geoscience still faces an image problem and difficulty in attracting science-inclined students. For example, at the high school that my daughters attended in the mid 2000's, students on the honors tract were advised to take biology as freshman, chemistry as sophomores, physics as juniors, and then to take an Advanced Placement (AP) courses in one of those sciences senior year. There was no provision in this sequence for the geosciences content on the HSPA exam, so prior to freshman year these students were required to teach themselves that material via extensive and tedious summer assignments – a very effective *disincentive* for any of them to continue in the geosciences!

This mentality is also evident at the university level; a 2010 survey at Northern Arizona University found that “students perceive geology to be the least difficult of the sciences, and geology occupations to be low-paying and low in prestige relative to the other sciences” (Hoisch and Bowie, 2010). And that modern authority *Wikipedia* states, “Within the areas of natural science...some disciplines are viewed as "harder" than others. For example, physics is viewed as harder than, say, paleontology since the former but not the latter can make precise predictions about experimental data.” (Geoscientists wrestling with the evidence, causes, and implications of mass extinctions would take issue with this last statement, of course!)

As educators, we can combat these attitudes by demonstrating in our instruction in very explicit ways that geoscience is as rigorous, empirical and relevant as any other science; indeed without the *science* there is no *geoscience*. But this means more than being simply “hands-on” or “inquiry-based,” especially when learning outcomes are narrowly prescribed by the instructor. Education must be more than the students trying to learn what the instructor already knows; students also need to be guided in how and why scientific investigations are done. But there is a balance to be achieved; students must be given background and skills sufficient to enable them to perform the tasks expected of them, but then given the freedom to perform their own investigations.

One way to achieve this is to model an investigation, and then have students apply that model to analogous problems of interest to them. For example, in our Natural Hazards class for non-

majors, two weeks of lab are devoted to the “Hometown Stream” project. To get the background, students visit a local stream, measure discharge, find evidence for high-discharge events, and see the USGS gauging station. In a subsequent class, the instructor models accessing and analyzing National Water Information Service (NWIS) discharge data for that local stream and how to integrate background information into a technical analysis. Students then chose a stream of personal interest, gather personal knowledge and background information, and download and analyze NWIS discharge data for their stream. It ends up being a very real investigation for both the student and the instructor. As an added benefit, oral presentations from classmates allow students to learn about streams quite different from their own.

As another example, I have been developing Google Earth-based activities to familiarize students with basic tenets of plate tectonic theory by having them investigate the major features of Earth’s topography, bathymetry, sea floor age, seismicity and volcanism. Students then test the theory by comparing long-term average plate motions (from sea floor age and hot spot track data) to near-real time motion (from high-precision GPS data). Students thus learn not only the basics by working with the data on which plate tectonic theory is based, but just as importantly discover the complexities: plate boundaries are not infinitely thin as depicted in textbook figures, plate motions change over time, internal plate deformation does occur and “hot spots” don’t work like hypodermic needles providing a constant, narrow pipeline of magma! That is, students learn the theory and encounter topics of current research.

These examples are targeted at introductory-level classes, but are easily be modified for upper-level classes, demonstrating that teaching science by doing science is an effective strategy at any level.

References cited:

Thomas D. Hoisch and James I. Bowie (2010), Assessing Factors that Influence the Recruitment of Majors from Introductory Geology Classes at Northern Arizona University, *Journal of Geoscience Education*: May 2010, Vol. 58, No. 3, pp. 166-176.

http://en.wikipedia.org/wiki/Hard_and_soft_science accessed June, 2012