Introductory geology at Cal Poly, San Luis Obispo: breaking down science barriers for non-majors

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Cal Poly offers two formats of Introductory Geology: GEOL 102 and GEOL 201 designed, respectively, to meet the needs of non-science majors completing their physical science general education requirement (GER), and Natural Resources majors that need a background in geology to fulfill their degree requirements. University wide, the primary goals of this physical science GER is to provide a basic understanding of the scientific method and examples of the application of scientific and mathematical results to society, breadth and depth in the sciences, and improved problem solving skills. However, whereas major students are typically interested and motivated to succeed, a high percentage of non-science majors approach their physical science GER with a lack of confidence, interest, and motivation. As such, I teach Introductory Geology for non-science majors at a slower pace, and using curriculum focused on locally-observed broad geologic processes, and pedagogy including lecture activities and min-lab discussion sections, that are designed to meet the needs of students who may initially have an aversion to the sciences and math.

While the goals of the physical science GER as outlined by the university are straightforward, one of the greatest difficulties that I have is getting non-science majors to appreciate the accessibility and/or relevance of geology, specifically, and the sciences more generally. I feel that geology as subject is particularly well-suited to combat this aversion and apathy toward the sciences, and I use curriculum that highlights the interdisciplinary and observational nature of geologic process that can be observed locally as a first method to break down the variety of different barriers students may have against science. For example, nearly all of my students are familiar with the California gold rush, and after refreshing their memories during the first lecture, I return to it throughout the quarter during discussions of mineralogy, igneous, sedimentary and metamorphic rocks, mountain building, and fluvial processes. Similarly, my curriculum repeatedly highlights simple chemistry and graphical math—for example, I use phase diagrams during lessons on mineralogy, igneous and metamorphic petrology, and glacial geology. In addition to enhancing the understanding of the scientific background to the geologic concept under discussion, for students that have struggled in science and math classes previously, I hope that the broad, and repeated application of these foundational themes empowers students scientifically by illustrating that our understanding of complex science processes frequently based on relatively familiar observations and basic science and math concepts. For students that may not feel that the physical sciences are relevant to their immediate lives, I hope that the use of local geology and the related sciences in my classes generates interest in the material, and a new appreciation for the role of the physical sciences in their everyday lives. Finally, by returning to several themes throughout the quarter, I try to emphasize that geology is not just a series of unrelated facts for students to memorize, but is actually a series of interrelated ideas that together represent tests of our understanding of the broader Earth processes. I think that this example of how the details of these seemingly isolated ideas could alter our understanding of broad Earth processes is a beautiful example of the scientific method, and I hope that my students come away from my class with a feeling that the

physical sciences are more accessible in that even small contributions play a role in our constantly evolving understanding of our world around us.

In addition to this curriculum tailored for non-science majors, we have also worked to improve the class format for introductory geology to better suit the needs of students fulfilling their physical science GER. Traditionally, multiple 60-student sections of this class were offered each quarter as a 4-hour lecture class. The new format, introduced last year, consists of three hours of one large lecture with up to 180 students supported by one-hour, 30-student discussion sections taught by the professor, and in which all students in the lecture are required to enroll for their fourth hour of credit. Lectures are still dominated by traditional PowerPoint and chalk board lectures, although small-group activities in which students apply lecture concepts to different geologic scenarios are increasingly emphasized and typically account for 15–30% of the lecture period. Discussion sections serve as mini-labs in which students gain experience making descriptive observations and interpreting data working through tutorials that accompany hand samples, maps, and graphs, while simultaneously providing an important opportunity for one-on-one interaction between students and professors. This move toward active and experiential learning was, once again, designed to make non-science students more comfortable with the scientific process while emphasizing the significant role that science plays in our society.

There have been no formal studies of the impact of these curricular and class format changes on the impact of non-science majors enrolled in Introductory Geology at Cal Poly. Anecdotally, however, student evaluations regarding the new class have been positive, and achievement of specific class learning objectives has improved on exams. Still, engaging these non-science students in class, and especially in lecture, remains a challenge. In future years, I plan to use a similar locally-focused curriculum while exploring different means including the use of on-line technology by which to increase the ratio of time occupied by small-group activities in lieu of traditional lecture. By making these additional changes, I hope to further engage my students to more completely meet the university-wide learning objectives of the physical science GER, and ultimately, to help my students become more scientifically literate.