Teaching Engineering Geology in a Geoscience Department

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I'm pleased to have this opportunity to share specific examples of how I integrate engineering and geoscience in an engineering geology course I teach and explain why this is important for preparing students for the workforce. I will also present my vision for building on these successes, and, finally, discuss the challenges of integrating sustainability concepts into an engineering geology curriculum.

I've enjoyed teaching Engineering Geology (GEOL 314) in the Geology Department at Western Washington University (WWU) for the past 15 years. Because I have a science and engineering academic background, developing and teaching this course has been professionally gratifying. The course, fundamentally, focuses on the core activities of engineering geologists – site characterization and hazard identification/mitigation through the collaboration with engineers. Engineering geologists understand the complexities of natural systems and are adept at synthesizing detailed field observations into coherent inferences. They bring their geoscience approach to problem solving that is unique and complementary to an engineering methodology. Engineering geologists are applied geoscientists with an awareness of engineering principles and practice—they are not engineers. In states that require professional licensing (e.g., Washington, Oregon, and California) these practitioners become Licensed Engineering Geologists (LEGs), not Professional Engineers (PEs) like geological engineers and geotechnical engineers.

A key learning outcome of GEOL 314 is for students to understand the mechanics of Earth materials and how they respond to forces and stresses. Geology students have some basis of rock stress and strain from structural geology, but I advance their understanding in GEOL 314 by exploring in more physical detail the mechanics of rock, soils, and fluids, and how these relate to site vulnerabilities. Given that most civil projects are designed to function on the order of decades, students learn how to view 'sites' of rock masses and soil deposits as dynamic systems that may regress in response to changing internal and external forces during this time frame (not millennia). Like a classical geologist, an engineering geologist can analyze a structurally altered outcrop and hypothesize about its tectonic evolution, but, they are equally competent 'characterizing the site' as a rock mass that may fail and potentially cause harm to people and property. I have found that student understanding of these physical concepts improves with the application of numerical modeling tools. In GEOL 314 students use a software package developed by Rocscience, Inc.© to study rock and soil slope stability and settlement processes—the software is very effective for visualizing and examining the sensitivity of key parameters on these dynamic Earth systems.

Students also learn in GEOL 314 that they are part of a team of professionals and that technical information is shared using standard methods and conventions. The team can include engineering geologists, geotechnical engineers, structural engineers, architects, and government regulators. I teach students to collect, synthesize, and report geologic data and information using standards in engineering practice—standards such as those established by the American Society for Testing Materials (ASTM), the Unified Soil Classification System (USCS), and the International Building Code (IBC). I also advance this collaborative theme and classroom theory by promoting interactions with regional professionals and exposing students to the actual practice through case studies. We actively network with practitioners, both engineering geologists and geotechnical engineers, who visit campus to discuss their case study experiences, share data from projects, and participate on field trips. This professional development is also fostered by the Washington Section of AEG and WWU's AEG Student Chapter—we take trips to AEG meetings in Seattle to listen to case-study presentations and talk with practitioners; and occasionally participate on AEG sponsored field trips.

My approach in GEOL 314 is valuable for preparing students for the workforce because they can appreciate the connections and application of their academic training in addition to learning engineering fundamentals. Motivated by the success in this course, I have introduced engineering concepts into multiple courses within our Environmental and Engineering Geology concentration at WWU. Assessment evidence indicates that students value the topics and are learning, and, graduates are getting jobs. Among the BS geoscience degree granting programs in Washington, WWU has produced the highest percentage of licensed professional geologists in the state. Some graduates have gone on to get higher degrees in geological, geotechnical, and environmental engineering and are now successful practicing engineers.

The demand for engineering geologists in Washington State is growing. Population growth, development in challenging geologic terrain, forest practices, sea-level rise, geologic hazard mitigation efforts, and government policy are increasing the demand for Licensed Engineering Geologists (LEGs). Demand grows at the same time retirements of LEGs accelerate - 50% of the current LEGs in Washington will be retired in a decade. To help meet the demand for LEGs, and to continue to build upon my current engineering integration success, I am leading the effort to develop a BS degree in Engineering Geology at WWU. It is important to note that even though WWU does not have a civil engineering program with which to collaborate, I'm confident that the model of building engineering geologists within a geoscience program will be successful.

I am challenged, however, by how to better address the nontechnical aspects of sustainable development in GEOL 314 and my curriculum. Engineering geologists have great potential to be part of the solution in complex resource management and civil project decisions; so I also want them to think about economics, and resource and environmental impacts, and other concepts like ethics and leadership that embody sustainability. Regrettably, geoscience students do not have the necessary foundation for these ideas because geoscience programs do not explicitly address them—programs focus on teaching science—making observations and critical inferences under the umbrella of the scientific method. The challenge with integrating these sustainability concepts is comparable to teaching effective writing. Students need fundamental coursework in writing (sustainability) in addition to practice within the discipline. This is my goal—to impart nontechnical sustainability concepts in my curriculum to strengthen the voices of future engineering geologists in the sustainable development conversation.