geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Catalyzing Undergraduate Education: Developing a Lab Manual in Forensic Geology

Gabriel J. Greenberg, Natalie Bursztyn, Emma C. Davy, Steve L. Quane
Quest University Canada

Summary

Geology has the potential to be taught as one of the most experiential and interdisciplinary fields in the physical sciences. As a student studying chemistry and geology as well as a prospective educator in training, it became clear that these fields contain a great deal of overlap with enhanced learning outcomes that could be achieved through experiential and interdisciplinary pedagogy. With the guidance of three professors at Quest University Canada, I (a fourth-year undergraduate student) produced a forensic geochemistry laboratory manual that exemplifies the promise of non-traditional and experience-based learning. This lab manual combines lab-based activities in geochemistry with a forensic narrative. This project lead to both improved conceptual understanding of chemistry and geology for myself as well as the production of multiple labs that will serve to enhance the learning outcomes of future undergraduate students who take this course.

Theory / Method / Workflow

The lab manual was produced with three main goals: 1) to build on existing lab skills as well as learn new ones, 2) to improve students' interdisciplinary thinking, and 3) to engage students with the material (make the learning fun). All labs require hands on learning; rather than simply being shown a concept on a white board, students are guided through a series of instructions in order for them to take ownership of their learning. Learning happens in real time and in person, encouraging the student to think critically about tough questions. For example, in one experiment, the students are given slurry from a local copper mine and asked to extract the copper by doing an acid digestion.

Figure 1: Copper mine slurry

Once the digestion is complete, iron filings are added to the digestion mixture to replace the and precipitate out the copper from solution. Seeing the copper fall out of solution creates a visual to contextualize the theory by showing students how miners actually used to extract copper at the local mine. Later, in the same experiment, students use UV-vis spectroscopy, along with a sample solution with a known copper concentration, to calculate the concentration of copper in the ore.

Figures 2 & 3: Measuring copper concentration using UV-vis spectroscopy

From there, questions are asked about the type of deposit and how it might have formed by using the copper concentration determined by UV-Vis spectroscopy. This representative example illustrates the use of combining chemical and geological thinking to gain insight on how a particular rock formation may have developed while exemplifying a use case for analytical chemistry techniques. The lab manual was written to engage students and to encourage them to participate critically. This was largely done via the hands-on nature of the labs as well as narratives relating to forensics. Students were asked about the copper concentration not just to learn about the local geology, but to discover the antagonist of a fictional murder plot with aloof and charismatic characters. In another experiment, students are asked to replicate and test the validity of a television show in which a body is turned to soap as a result of chemical and geological processes (decomposition in an alkaline acquifer).

Results, Observations, Conclusions

Beyond the theory motivating the lab manual, having an undergraduate student work on this project also served to illustrate the importance of experiential learning. I was initially encouraged to learn about geology by taking a field geology course. This provided visuals for the theories presented in class by traveling to several interesting geologic sites in the Sea-to-Sky corridor. In addition, this experiential course focused on thinking critically and using real time observations as a basis for making informed hypotheses as to the geological history of an area. This is a skill crucial in geology that is very difficult to attain just studying theory in a classroom. The second half of this project involved piloting the experiments for this manual in lab spaces. Through piloting these experiments, I had to think deeply about which experiments to design, how to troubleshoot things when they were not successful, and how to connect these experiments to a creative forensic narrative. This manual will in turn be used to enhance the learning of other students in a future Forensic Geology (Geochemistry) course.

This interdisciplinary lab-based educational tool, disguised as crime scene investigation stories, is intended to engage students with experiential learning opportunities. In turn, these experiential learning opportunities provide training in a particular skillset that is difficult to achieve in the traditional classroom alone. Furthermore, by encouraging a senior undergraduate student to take on a teaching role in the prosses of creating the lab activities served to deepen that student's conceptual understanding of both geology and chemistry and the area in which they overlap. Much of geology is observation, experimentation, and critical thinking. Determining the story of an ancient rock formation can be assisted by many small observations in the field and through lab-based experiments. Being able to make interdisciplinary connections such as the relation between geology and chemistry and being encouraged to make real decisions (with consequences) in the field serves to empower students to think critically and overcome learning barriers associated with this physical science.

Acknowledgements

Dr. Natalie Bursztyn, Dr. Emma Davy, and Dr. Steve Quane, as well as Quest University Canada for making this all possible.