Learning geoscience by doing geoscience – by Paul Kelso, Lake Superior State University

As is the case with many faculty, my teaching methods and strategies have evolved over the years. I learned geoscience primarily though traditional lab and lecture and this is how I initially structured my classroom. I lectured, did a variety of demonstrations and students applied concepts though laboratory activities and homework exercises. This appeared to be successful as students generally preformed well on assignments and exams.

After teaching for a number of years I became frustrated with student retention of material and their application of previously learned concepts to new situations. When teaching upper division undergraduate geology classes I often ask students to apply concepts that they learned in a previous class. I don’t know if you have ever had this experience, but students would often tell me, “no we didn’t study that in such and such class.” Then I would inquire with colleagues and they would say yes we covered that material. Students would even tell me, “no you didn’t cover that topic in class the previous year.” After discussion of particular examples related to the topic that we had previously discussed and then they would begin remember that they had heard that before, but often had difficulty seeing the connection and applying these concepts to the new situation in their current class.

I have modified my teaching to try to address student’s retention and application of concepts. Now student activities often model the professional geoscience experience, thus students practice working as geoscientists. This has involved a redesign of my courses so that they focus on the process of doing geoscience rather than the traditional discrete, content-centered courses. Courses now are problem-centered, concentrating on important geologic problems and emphasizes sub-discipline integration. Courses are structured to integrate fundamental geoscience concepts from sub-disciplines presented in the context of sequentially ordered problems that reflect increasing structural complexity, different depositional regimes, and different igneous and metamorphic petrogenetic models. Most courses have field component to promote in-depth understanding of real world geologic problems. Individual student projects are designed to promote the comprehension of fundamental concepts through its application to solve significant geological problems. The application of concepts to answer questions students have from their field based projects motivates students to learn, internalize, and apply concepts.

This course pedagogy is based on these key principles: learning is constructivist, experiential, investigative, inquiry-based, and collaborative within a community of student-scholars. Constructivist teaching/learning theories are applied that emphasize active learning which helps students construct a strong knowledge framework and enhances motivation, learning and retention, problem solving, critical thinking and communication skills. Active cooperative learning increases conceptual understanding and student achievement and helps students overcome misconceptions. In our paradigm, individuals actively construct new knowledge by building on what they already know while hopefully discarding misconceptions. Students develop higher level thinking skills and construct new knowledge by participating in a community of learners, by making observations and developing a conceptual understanding, while learning terms and facts, and by actively explaining their understanding of concepts. Learning progresses as students work collaboratively, discuss their progress, encounter different interpretations, bounce ideas from each other, and challenge each other’s conclusions.

The focus on field based projects requires students to: make their own observations, decide what information is important to collect and how to collect it, often collect a variety of information related to different geoscience sub disciplines, revisit key concepts at increasing levels of sophistication on succeeding projects, decide what is not important, decide how to focus their time and energy give the project objectives and time constraints for the project. The identification of real problems for the students to address provides a context for the problem, generally requires students to consider concepts from multiple sub disciplines, and provides student motivation to solve the problem. This has resulted in improved student retention of materials and it application to new situations as they practice this on multiple projects.

Many of the projects are designed so students are involved in all aspects of a project. Thus the students must propose and justify the method to solve a problem, design the study, carry out the study through the collection of data, process and interpret the results, and present the conclusions/recommendations both written and orally. Thus projects model the work that a geoscientist might undertake working in industry or academia.

Developing activities where students learn the methods of geoscience by modeling the behavior of professional geoscientist has resulted in a significant change in what students learn and how they apply this knowledge to geologic problems. Students are now learning geoscience by doing geoscience. It is exciting watching students as they learn to answer and ask questions, as they tackle increasingly sophisticated problems and as their confidence grows as they develop as geoscientists.

Taught traditional geology lab lectures for years

Weakness –

Retention of concepts

integration of concepts from different disciples/courses to solve problems

differs substantially from traditional curricula in which knowledge is too often compartmentalized and students have difficulty making important connections among sub-disciplines.

Students learn by doing

requires student problem-solving and critical thinking, utilizes active learning strategies that model scientific endeavor, provides a focus for sub-discipline content application

Model professions geoscience experiences

Real world experiences solving geoscience questions

Students practice integrating information from multiple sub disciples to solve problems

Revisit concepts a increasing levels of sophistication in multiple courses

Focus on field based learning

Require integrating a variety of information

Collected information is often from multiple disciplines

Students have to learn what is important, what to focus their attention on