Developing and implementing *in-class activities* for a class of 65 non-science majors

GEOL 2100: Environmental Geology
Professor: Alexis Templeton
STF: Leilani Arthurs

*First step -- find happy folks to test things on:* Mayhew, Barrett, Arthurs, & Chait (Fall 2008)

*Then -- it’s time to implement them in class:* Templeton & students (Fall 2008)
GEOL 2100: Environmental Geology is an introductory level course that is designed for non-geology majors.

The course is both local and global in scope.

Local: Colorado and the Front-Range

Global: China, Saudi Arabia, Bangladesh, etc.

The course framework is structured around the following modules:

1. Physical Geology
2. Water as a Resource
3. Water Quality
4. Minerals as Resources
5. Rocks as Repositories
6. Energy Resources

Figure 1. Image used in class lecture.
Overarching learning goals for **GEOL 2100** include awareness, attitudinal, and conceptual student learning outcomes.

**At the end of this course, I hope that students will:**

Recognize that newsworthy events related to Environmental Geology occur every day.

Feel confident in their ability to invoke geological information to decide how humans should best use (or not use…) the landscape that surrounds them.

Be able to use primary data to determine the source of an environmental problem.

Be able to theorize about how humans can affect geological cycles, particularly due to the rate humans transform water, energy and mineral resources at both a local and global scale.

Be able to identify the geologic processes that generate and replenish water resources, and the timescales over which they operate.

Recognize that rocks have both physical and chemical properties, and be able to illustrate how these properties control how rocks interact with water.

Assess how the history of our past water, energy and mineral use guides any efforts to develop new resources.

Analyze the geologic factors that cause or mitigate threats to water quality.

Be able to evaluate the risks associated with waste disposal in geologic media.
Our purpose for designing interactive components into *GEOL 2100: Environmental Geology* was to promote engaged participation, active learning, and a sense of individual empowerment.

---

**Figure 2.** Rock Cycle Exercise: (a) Student teams circulate around the room to different rock stations. Professor and assistants circulate to facilitate student discussion and probe their thinking. (b) Student team working together on worksheet. (c) Student sketches the rock cycle developed in his team.
In-class activities:
A mechanism to address higher-level learning goals??

Five in-class activities were designed to stimulate:

1. Integration of geologic processes that transform one rock type into another.
2. Interpretation of geological maps to predict the distribution and availability of water in the subsurface.
3. Evaluation of what constitutes “clean” or “safe” water?
4. Use of hydrogeological information to assess a community water threat.
5. Assessment strategies to extract mineral resources and proposing better environmental practices.

The pedagogy that supports in-class activities:

1. Promote active student learning.
2. Decrease the student-teacher ratio and improve one-on-one contact time & support between student and professor or teaching assistants.
3. Draw out shy students such that they are more likely to verbally request help in the small-group setting.
4. Enhance collaborative learning! For example, the GEOL 2100 students say “they get different perspectives and ideas from their peers.”

In-class activities were implemented with the same overall format:

1. Form 16 groups with 4 students each. Students were assigned to different groups for each activity.
2. Introduce the activity to the entire class. Students then assemble into pre-assigned groups and work together on the in-class activities and handouts.
3. Templeton, Arthurs, Mayhew, and 2 undergraduate teaching assistants circulate to facilitate student discussion and probe student thinking.
4. Close the activity with the entire class. Whole class is reconvened for “Group Clickers” and large group discussion.

Figure 3. Students assemble into groups.

Figure 4. (a) Group Clickers and (b) large group discussion.
In-class activities:
Example 1 – Subsurface Water/Aquifers in the Denver Basin

Figure 5. Measuring infiltration rates
Figure 6. 3-D Visualization of Geologic maps

Figure 7. Water “races”: Porosity and Permeability
Figure 8. Analyzing aquifer properties
In-class activities:
Example 2 – Arsenic in Bangladesh, a capstone exercise

**Step 1:** Divide class into 3 large groups. Each group is “trained” to be Geologists, Water Consultants, and Villagers.

**Step 2:** Small teams are formed with 1 Geologist, 1 Water Consultant, and 1 Villager. They evaluate options for obtaining “safe” Arsenic-free water.

Figure 9. Three large groups in “training.”

Figure 10. Small teams evaluate the pros and cons of different methods for producing “safe” water.
Challenges to implementing these in-class activities exist; however, the success of the activities made them worthwhile.

Challenges dealt with student collaborative skills, logistics, etc.:

- **Teamwork**: Would all the students actively participate and contribute?
- **Preparation**: Were the students well prepared to apply basic principles or did confusion immediately ensue?
- **Scope**: Were the activities well-designed to provoke conceptual thought?
- **Time**: Could they assimilate and assess the information with limited time?
- **Guidance**: How could the instructor(s) interact with all 16 groups of 4 students?

Biggest question that arose every time:

Q: Are they worth all the time and effort?
A: Yes!

Biggest sense of success:

- Collaborative learning through the in-class activities set the stage for broad thought & developed individual skills.
- The in-class activities set the context for follow-up home-works were in-depth, drove the integration/synthesis of major concepts, and were completed on an individual basis.
Students believe that the in-class activities help their learning.

Figure 11. Student evaluations of how helpful in-class activities were.

98% students state the activities are helpful.

92% say they are much to very much help!

Figure 12. Student rankings of what they most helpful to their learning.

The data shared here are for the Fall 2007 iteration of the course. Fall 2008 data are similar.