# Mentoring Graduate Students at Colorado College:

Expanding the Pipeline by Educating Future Educators

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Objective seven of the CMMAP Education Plan is to teach the next generation of climate scientists to become better educators. One key strategy to accomplish this objective is to provide an opportunity for Colorado State University (CSU) graduate students to literally be thrown "into the fire" and co-teach an upper division Atmospheric Physics and Chemistry class at Colorado College (CC). This activity is essential because knowledgeable and exciting teachers have the potential to significantly increase the number of students coming into the field as well as enhance scientific literacy for non-majors. We believe that educators can maximize the flow of students into the field and those exposed to ideas in the field by:

- Improving pedagogy
- Incorporating more hands-on and inquiry based learning
- Getting involved with all level of students

Pedagogy:

Many, if not all students have spent time in a class where the professor lectured the entire time, filling "the pool of knowledge" and the students were expected to be sponges and soak up as much information as possible. This traditional view of teaching can work for some, but not for all. Current cognitive research[3] provides five key ideas about how students best learn. This research found that students learn best by:

- constructing their own understanding based on prior knowledge, experiences, and skills.
- following a learning cycle or exploration, concept formation, and application.
- connecting and visualizing concepts and multiple representations.
- discussing and interacting with others.
- reflecting on their progress and assessing their own performance.

These five points are integrated into the teaching approach we followed for the block. It is called the Process Oriented, Guided Inquiry Learning (POGIL) approach. Its dissemination for chemistry classes has been, funded in part by the NSF, Division of Undergraduate Education. Using the POGIL approach, we transformed our classroom from a scene depicted by the black and white photo our classroom in the color photo on the left. This approach requires that the students become more responsible and engaged in the learning process. Students work together to solve worksheets that require them to construct concepts from data and graphs; students must put the pieces together to truly understand the material. A brief excerpt from one worksheet we designed for this block follows.

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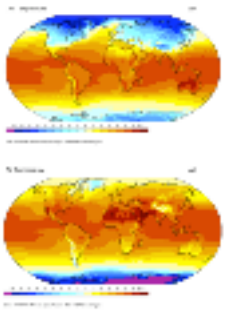
[3] Bransford, J.D., A.L. Brown, and R.R. Cocking, eds.. *How People Learn: Brain, Mind, Experience, and School.* Washington, D.C.: National Academy Press, 2000.

A POGIL example:

Below is the average global surface temperature for January and July (NCEP Reanalysis).



1. Compare the equator to North Pole temperature gradient in January to the equator to South Pole temperature gradient in July. Which is stronger? Why?

2. Using the thermal wind equations (introduced earlier in the worksheet) and your response to question 1, would you expect the winds aloft to be stronger in the northern hemisphere during January or in the southern hemisphere in July?

3. Based on your responses to Q1 and Q2, would you expect the Arctic or Antarctic stratosphere to become more isolated in their respective winters?

After the students work through the worksheet, a debrief is very important. Asking the students to explain how they answered questions forces them to deeply understand the material. One thing we will try in the next iteration is to have a jigsaw structure where members of different student groups go to other groups and explain their answers.

Using the POGIL system, the professor has four roles: (1) Leader, (2) Monitor/Assessor, (3) Facilitator, and (4) Evaluator. As a leader, the professor designs the worksheets and explains the objectives of the course. While the students work on the concepts, the professor monitors the groups and assesses their performance. If the discussion within the group wanes or gets off track, a well-placed question can get the students discussing the concept again. Finally, the professor evaluates progress through the debriefing described above.

**Hands-on and Inquiry Based Learning:**

The CMMAP grant allowed for the purchase of eight radiosondes for the course, allowing the CC students to enhance their hands-on learning experience (the students launched the balloons). During the Air course, the students were asked to become science-minded by designing and executing a study evaluating the health effects of air pollution at two proposed sites for a new children's center. The students used a number of lab instruments and evaluated historical data to assess the air quality at two local sites to determine where the children's center should be located. In this project, the students took the lead for the learning process.

Get them while they're young:

Crucial to CMMAP's success is increasing the "web of connections" from research scientists to elementary students. The radiosondes provided an excellent opportunity to reach out the youngest of future scientists.

The Catamount Institute's Young Environmental Stewards (YES) 4th - 5th grade students came out twice to the weather balloon launches. Under our direction, CC students let the YES students launch the weather balloon and take atmospheric measurements. During the balloon flight, the students were able to ask us some excellent scientific questions. These two launches were great experiences for the students. Such interactions, which indicate that science is exciting and fun, are essential to expanding the pipeline into the atmospheric science, or any other scientific field.