Teaching Philosophy — Rebecca Clark

Excellent teaching is an active and reflective exercise to change students' understanding about the world, and exert a positive influence on how students think, act, and feel. Translated to teaching in biology, my broad **objectives** are: (1) provide students with perspective about the living world and how it works, (2) encourage critical thinking skill development, (3) help students understand how fundamental scientific knowledge and insights arise, and (4) empower students to contribute to the development of scientific understanding.

My experience comes from 16 semesters/summers with students in large, introductory Biology courses. While it is tempting to try and compact all biological knowledge to fit these courses, students are best served by two slightly different foci: an *introduction* to specialties within Biology that highlights **big and unexpected findings**, and extensive **practice with scientific literacy**, the fundamental components of the scientific method, and experimental design - that is, experience with the tools for scientific thinking. These goals can be achieved by presenting courses through the lens of the history and nature of science, walking students through methods used by historic figures (Gregor Mendel, Robert Koch, E.O. Wilson) to reach insights.

A difficulty with this approach, however, is that **if only historical insights are emphasized, students lose touch with the fact that biology is a dynamic, changing field**; debates rage, and there is room for further contributions. Students need to be exposed to this aspect of science as well. This can be uncomfortable for those accustomed to thinking of biology as a static body of knowledge, so thought must go to empowering students to face the challenge. Two methods for doing so are to **bring in one's personal stories and research**, and to make learning student-centered - that is, tap into a person's natural curiosity and **encourage direct observation, exploration and action**.

A cherished teaching moment comes from a semester I brought colonies of the local leafcutter ants into an introductory biology lab, and had students design experiments on the ants' behavior. Students were hooked, asking all sorts of questions as they observed the ants' activities. In teams of four, they developed **causal questions, hypotheses, predictions, and experiments** and then explored whichever aspect of leafcutter ant behavior captivated them; there was no basis for their projects aside from that stemming from direct curiosity, and no "right" answer in their experimentation.

This exercise exemplifies how I realize aspirations as a teacher and research mentor: it is **inquiry-based and creative**; *plus* it introduces students to a **novel system** they might not have noticed or understood if left to their own devices. Earlier in the semester, I gave students an overview of the primary literature so they could analyze how scientists communicate, and we had practiced hypothetico-deductive reasoning, experimental design, and basic data visualization and analysis methods. Once the students collected their quantitative and qualitative leafcutter data, they took the results home and used their findings to write individual reports following the structure and format they observed in the primary scientific literature.

Thanks to consistent practice of good reasoning skills, plus the previous writing experience, by that stage most students had mastered a basic ability to think and communicate as scientists. I knew, however, from training as a Writing Fellow, that **most students do not know how to draft and revise writing effectively, because they rarely have structured opportunities to revisit their thinking**.

Good revision skills are critical for success. Once students turned in their reports (thinking they were completed), I returned them, ungraded, with a detailed revision checklist, and had students exchange reports. They spent several minutes carefully reading and responding to each other's ideas, and then went home to rewrite – after all, **this is what practicing scientists and professionals do**. The result was rewarding; students demonstrated mastery of the scientific process; their writing was polished; and I could provide feedback on ideas rather than basic logic and formatting issues. Students were grateful for the opportunity to demonstrate mastery of the material, and for the chance to revisit and develop their thinking. The clearest indicator was the horde of students who visited office hours between drafts, compared to a lack of students attending office hours before the initial paper deadline.

On an individual level in the Fewell and Behmer labs, I promote the development of scientific thinking skills with the **goal** of **having student-researchers conduct projects of their own devising**. Research begins as an apprenticeship: students learn about the types of research in the lab, assist with a preexisting project, and acculturate to research lab operation. From there, students use initial observations to formulate questions. Together, we evaluate the feasibility of each question and narrow to a project that can be conducted with the time and resources available. **As the project plan comes into focus, students begin the writing process**. I then act as an ambassador, connecting students to resources, and providing structured opportunities for the students to work on writing, reading, thinking, and presentation skills. Undergraduates often struggle with statistical analysis, so this receives attention during experimental design, data collection, and analysis, with an emphasis on how statistics aid in decision-making about findings. This approach's success is visible in the 4 independent, creative honors theses I have co-supervised, and in the 6 students (5 women and/or minority) out of 14 who have pursued advanced degrees.

I also apply this scientific approach to engage broader audiences. For example, two undergraduates and I developed interactive, inquiry-based "speed science" experiments for middle-school girls attending a science festival. I also created inquiry-driven ant-related articles for the Ask-A-Biologist website (http://askabiologist.asu.edu), an interactive educational resource for K-12 students and teachers; AAB won Science's SPORE prize (Science Prize for Online Resources in Education, Science 330:1192-1193) for its innovative methods of public engagement, and it is heavily visited.