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. My **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 are communicated, and (4) empower students to contribute to scientific understanding. My intention is to use evidence-based teaching methods to teach concept-focused courses with an emphasis on the development of communication and critical-thinking skills. The specific implementation will be tuned to the size and nature of the course at hand, whether a general survey course or upper-level course in social evolution, behavior, or comparative physiology.

My experience to date has been with large, introductory Biology courses. In survey courses I give an *introduction* to specialties within Biology to highlight big and unexpected findings. I emphasize practice with scientific literacy, the components of the scientific method, and experimental design - that is, experience with fundamental tools for scientific thinking. These are achieved by presenting courses through the lens of the history and nature of science – i.e. walking students through the methods that historic figures (Gregor Mendel, Robert Koch, E.O. Wilson) have used to arrive at key biological insights.

However, **if only historical insights are emphasized, students lose touch with the fact that biology is a dynamic, changing field**; debates rage, and further contributions are needed. Students tend to enter college thinking of various disciplines as static bodies of knowledge and thinking of themselves as passive receptacles of information. Two methods I use to change this view are to **bring in personal stories and research**, and to **make learning student-centered** - that is, tap into natural curiosity and encourage direct observation, exploration, and action.

For example, one semester I brought colonies of my leafcutter ants into an intro 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 groups, they developed **causal questions, hypotheses, predictions, and experiments** and explored whichever aspect of leafcutter ant behavior captivated them. Direct curiosity served as the basis for their projects and ensured there was no "right" answer in their experimentation, as with modern science.

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, we examined the primary literature to analyze how scientists communicate, and we routinely practiced hypothetico-deductive reasoning, experimental design, and basic data visualization and analysis methods. This meant that once students had quantitative and qualitative data in hand, they could use their findings to write reports following the structure and format observed in the primary literature.

Thanks to practice, by that stage most students had mastered the basic ability to think and communicate as scientists. However, **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. Once students handed in papers (thinking they were finished), I returned them, ungraded, with a detailed revision checklist, and had pairs of students exchange reports. They spent several minutes 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 marking basic logic and formatting issues. Students were grateful for the chance to show mastery of the material, and revisit and develop their thinking. The clearest indicator of this was the horde of students who showed up for office hours between drafts, compared to the trickle of students who visited office hours before the first paper deadline. As one student wrote on an evaluation, "I think I've learned how to think more critically and to write more fluidly within a scientific context. The broad exposure to various scientific fields and discussion of the importance and availability of laboratory experience has compelled me to seek out a research opportunity."

With student researchers, I promote the development of scientific thinking skills with the **goal** of **having students conduct projects aligned with their specific interests**. Research begins as an apprenticeship: students learn about the types of organisms and research in the lab, assist with a preexisting project, and acculturate to lab operation. From there, students use initial observations to formulate questions. Together, we evaluate the feasibility of questions and narrow to a project that is practical with the time and resources available. **As the plan comes into focus, students begin the writing process**. I then act as an ambassador, connecting students to resources, and creating structured opportunities for students to work on writing, reading, thinking, and presentation skills. New researchers often struggle with statistical analysis, so this receives special attention during experimental design, data collection, and analysis, with an emphasis on how statistics aid in decision-making. This approach's success is visible in the 4 honors theses I have co-supervised, and in the 6 students (5 women and/or minority) out of 15 who have pursued advanced degrees.

I also apply this 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 articles about ants 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.