GUEST COMMENTARY

Melanie Peffer

"I Have *Learned* to Hate Science"

Every semester, during the first week of my non-science-majors biology class, I asked students to tell me what they were excited and nervous about that term, and if there was anything that they believed I needed to know about them. The quote that serves as the title of this commentary was among the most memorable responses I received. Sadly, this student was not an outlier. Many students shared their distaste for science or their nervousness about the class because, as they had come to believe, they were "not good at science."

Lukewarm attitudes like these were common at the inception of multiple semesters. For the majority of these students, this was their last formal science class – their final opportunity to build positive associations with the content of biology and to generate the confidence needed to engage with society's biology-related questions. That's a big, and important, responsibility for an educator.

The negative comments led me to ask some important questions. Where do these attitudes and beliefs come from? How might we, as biology educators, address them? Why do some students have a disinterest in, and a lack of confidence to engage with, biology or science in general?

Those of us who pursued careers in biology education likely did so because we were excited to share our love of biology. For those who don't feel that love, maybe it is cultural attitudes toward biology as a difficult subject that are to blame. Or movies and books that portray scientists as lacking scruples; or as logic-driven, emotionless creatures like Spock from *Star Trek*; or as the bad guys in a plot. Maybe our love for biology is lost on others because of various instructional and institutional barriers. Maybe it is the focus on testing. Teaching students to be confident in navigating the muddy waters associated with bioethical issues is vital, but perhaps these competencies are not assessed on standard exams and are minimized in instruction. Introductory biology courses are notorious for an emphasis on memorizing terms. Why would students seek new educational experiences if they believe biology is an accumulation of facts and concepts about the natural world that they can easily access with a smartphone?

I realize that terms and concepts are important, and I'm not advocating their banishment from the classroom. Instead, I propose we move toward teaching them as part of "value added" experiences that foster new conceptualizations of biology. For example, if we consider how students reason about and interact with biology in their daily lives, we might design a more durable educational experience. We should focus on what is relevant and interesting to students and teach content in a way that taps into students' emotions, interests, lifetime needs, and experiences outside the classroom. For example, cancer is a disease that is relatable to students. A more relevant way of teaching mitosis would be to show how chemotherapeutics treat cancer by disrupting microtubules and causing the cells to stop dividing. *Microtubule* is thereby changed from an abstract term to a way of understanding cancer treatment.

I have also found that students may grow to have positive attitudes toward biology if I approach instruction from an interdisciplinary perspective, intentionally connecting what we are learning in class to different fields – for instance, by talking about epigenetics in relation to how prenatal or early trauma influences the trajectories of human growth and development. I had a business student whose capstone project examined business models associated with how research dollars are raised and spent – this was, he told me later, his first positive experience in a science course.

I am always looking for things to share with students to emphasize that the concepts covered in class are not as abstract or foreign as they may seem. When we covered the properties of water, I shared a picture of an Olympic swimmer, taken seconds before the pool's surface was broken, when the water molecules were still joined together to create an eerie sheen on the swimmer's face. My husband frequently laughs at the times I say, "WAIT, I need to take a picture of that to show my students!" My recent attempts to show the biology around us include showcasing my family's adventures (and misadventures) with composting and the science behind why composting is better for the environment than sending organic waste to a landfill. Demonstrating the relevance and importance of biology in my own life also models this behavior to students. My passion for fostering excitement about biology has turned into writing a book, *Biology Everywhere*, on how biology relates to all aspects of our lives.

In spite of the distractions educators face, I contend that one of the most important things we can do is to leave students with positive feelings toward, relevant associations with, and confidence in science and biology. There are only three things we can teach: knowledge, skills, and attitudes. Attitudes tend to receive the least attention, but if students feel confident in their ability to engage with and understand biology, they'll continue to want to learn biology long after they leave our classrooms. I also encourage administrators to be agents for policy change, considering how best to support educators' efforts to help students develop not only content knowledge, but confidence in engaging with that content.

It is important for all of us to take a moment each day to remember the biology around us and to think of new ways to engage students positively in the immersive biological world in which we all live. In what way have you experienced biology today? Have you shared that with your students? Tell me on Twitter: @Melanie_Peffer #biologyeverywhere.

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