ISB Systems Education Experiences

BOEING

SYSTEMS THINKERS IN STEM

A CONVERSATION WITH:

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Which systems thinking skills do you use?

#1: Explore Multiple Perspectives
When I develop hypotheses and the experiments to test them I try to consider lots of different perspectives to brainstorm many explanations to a phenomenon.

#10: Characterize Relationships
I try to identify and characterize relationships between phytoplankton and the biotic and abiotic world around them. Some of these relationships can be quantified, and some cannot.

#15: Respond to Changes Over Time
Phytoplankton live in a dynamic environment – it is chaning all the time. Sometimes important changes happen in a few hours. Sometimes those important changes happen over decades or longer. Coming up with new ways to measure relationships and their changes over time is a challenge and a key part of the research.

1. **What is your role within the STEM community?**
   My role in the STEM community is two-fold. First, I research how phytoplankton--tiny cells in the ocean--contribute to the working of the Earth. That means I spent time thinking, reading publications, working with my collaborators, using oceanographic equipment out at sea, performing experiments in the lab, and communicating my discoveries with the scientific community. My other role is as a mentor for students who are building their skills in systems sciences. I train students in techniques, critical thinking, systems thinking, and work to translate my research into curriculum for university and high school students.
2. **What complex problem do you address in your work?**
   The complex problem we face is in determining which factors control the lives and work of phytoplankton. As these organisms live in the ocean, they are subject to complex physical, chemical, and biological processes. We need to figure out how these processes interact with phytoplankton, from the single-cell scale to the ocean-basin scale, and then control their contributions to the Earth System.
3. **What elements do you need to consider when addressing this problem?**
   When addressing the problem of *What controls phytoplankton?* we need to consider as many dimensions and scales of the problem as possible. One example is the role of wind in changing their habitat. Wind causes the surface water of the ocean to churn. The cells living in the surface are then moved up and down, so their access to light changes constantly. As photosynthetic cells, phytoplankton need light for energy, so they have evolved many intricate cellular and molecular strategies to keep harvesting light even when it fluctuates. So in order to work on such a problem, we need to understand global wind patterns, the physics of water-wind interactions, and the proteins and genes within cells that let them respond to their environment.
4. **How did you get to where you are today?**
   Wonderful teachers in middle and high school connected me to the science of the natural world and I was drawn to details of how plants and animals worked. In college, I learned about scientists who searched high and low for microbial life in many Earth ecosystems. Learning about the diversity of microbes and the sense of adventure in science drove me to research microbes in the ocean. Over many years, I grew my skills in microbiology and oceanography in the lab and in the field, often through the support of mentors and colleagues. In order to continue this research independently I sought a research professor position where I could ask questions on how microbes in the ocean work, and contribute to the development of new generations of young scientists.
5. **What advice do you have for becoming a systems thinker?**
   I encourage you to cultivate in yourselves creativity and a sense of wonder. Creativity will be handy for problem solving and will allow you to see problems from many directions, come up with new ideas, and devise new solutions to old or new problems. Use your creativity to ask questions about the things you see and brainstorm all possible explanations. Also use creativity to imagine the kind of work you want to do and how that fits into big and small problems that face our society. Developing a sense of wonder will help you stay connected to the big picture of why we do science and connect you to the beauty and complexity of the natural and engineered world we live in.