ISB Systems Education Experiences

BOEING

SYSTEMS THINKERS IN STEM

A CONVERSATION WITH:

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PRINCIPAL SCIENTIST AT INSTITUTE FOR SYSTEMS BIOLOGY

Which systems thinking skills do you use?

Skill #6: Recognize systems
Dr. Orellana recognizes systems by studying the connections and dynamics between phytoplankton, diatoms, climate change, dissolved CO_2, and ocean acidification (OA).

Skill #14: Predict future system behavior
Dr. Orellana studies how phytoplankton has changed over time to adapt to climate change, in order to predict how key ocean systems will react in the future to ocean acidification.

Skill #3: Respond to uncertainty and ambiguity
Dr. Orellana explained that the ocean was mysterious and unknown to her as a child, so during her undergraduate studies she began to pose environmental questions. She mentions that these questions are still relevant in her current work, and she's constantly doing research to study these questions and address uncertainty about the future of diatoms in the ocean.

1. What is the complex problem that you address in your work?
I study the response of phytoplankton to climate change, particularly the response of diatoms to OA as well as its effect on carbon sequestration. Due to anthropogenic activity, excess atmospheric CO_2 dissolves in the oceans, and as a result, they become more acidic. It is predicted that by the end of the century the oceans will have changed from pH 8.1 to pH 7.6. In order to forecast the diatom's future, we must understand how phytoplankton, in general, and diatoms, in particular, will adapt to future ocean conditions.

2. What do you need to consider when addressing this problem?
Understanding the response of organisms in their environment requires understanding their interactions with that environment. This includes their genetic makeup, their expression, and the biotic and abiotic environment of the organisms. Learning about all these elements takes time, dedication, and the ability to analyze all the appropriate data to discover all the interactions.

3. How did you get to where you are today?
I wanted to be a scientist since I was around 8 or 9 years old. I loved to observe tiny and beautiful creatures under the microscope. I have always been fascinated by the ocean, its motion and how tiny creatures adapt to live in the marine environment. I grew up in Chile, a narrow and long country by the Pacific Ocean. The ocean felt mysterious and unknown, and many questions were unanswered. While studying biology and zoology at the Universidad de Concepción, I began to pose questions. Those questions are still relevant; thousands of new genes have been discovered in the ocean; we now know that the ocean's biodiversity is greater than the land's! My passion for science brought me to the USA to pursue graduate studies at University of Washington. I focused on studying diatoms, climate change, carbon cycling, and carbon sequestration.

4. What advice do you have for becoming a system thinker?
For the young system thinker, my advice is to follow your dream, and learn the sciences but also technology, learn math and get computational skills, and don't forget music and literature! All of them help you improve your imagination. Have an open mind to look at questions in different ways that can reveal new areas of thinking and research.

5. How can students learn more about your work?
I also design the content of STEM curriculum modules for high schools. I manage them and assist with their dissemination. Specifically, these modules teach students how to use interdisciplinary STEM practices to understand and investigate climate change, carbon cycling, and OA. The module entitled "***Ocean Acidification: A Systems Approach to a Global problem***" has been adopted as an official curriculum by the CA State Board of Education and is being used by approximately 1.8 million high school students across the state. I have also designed a module soon to be released entitled "**Carbon's Fate: *Tracing Paths through Air and Sea***."