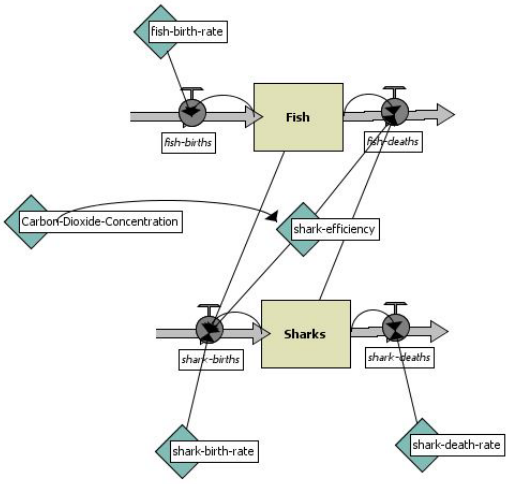
Curriculum Supplement Series
Gaining Insight through Systems Thinking and Computational Modeling

ISB Systems Education Experiences

In this set of online activities, high school and college students in statistics, math, computer science, environmental science, physics, integrated science, biotechnology, and STEM courses are prepared to use systems and computational thinking to explore today's complex issues and questions. Lessons may be completed independently or as a class.

Are you a student who is interested in field testing these modeling projects? If so, please see this webpage: https://sites.google.com/systemsbiology.org/gaininginsight



The Baliga Lab at the Institute for Systems Biology has been translating their research into user-friendly curriculum modules since 2004 through the program, Systems Education Experiences (SEE). By forming collaborative teams comprised of students, scientists, and educators, today's research and methods have become accessible, interactive activities for students. These activities work toward bridging the distance between the professional lab, computer science, and the classroom.

The Next Generation Science Standards use two words extensively that are relatively unfamiliar to many teachers. These two words are "Model(s)" and "System(s)". These activities address both systems and model building. Although this is designed as standalone instructional materials, it is connected to, and builds on, materials and ideas developed in the other SEE units.

In this module, students focus on the role of math and computer-based modeling to learn how dynamic systems models are developed, evaluated, and applied to understand complex scientific issues such as population explosions, food sustainability, cancer, energy, climate change, and ocean acidification. The module is written for students to walk through the activities at their own pace, using their preferred modeling software, such as NetLogo, STELLA, Vensim, and Insight Maker. Once basic dynamic modeling and systems concepts are addressed, students are able to "choose their own adventure" by selecting from a suite of case studies.

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Sample of NGSS & Common Core Standards Addressed	**Sample of Questions Explored**
SEP1 -Asking Questions and Defining Problems SEP2 -Developing and Using Models SEP4 -Analyzing and Interpreting Data SEP5 -Using Mathematics and Computational Thinking CCC1 -Patterns CCC2 -Cause and Effect: Mechanisms and Explanation CCC4 -Systems and Systems Models CCC6 -Structure and Function CCC7 -Stability and Change LS2 -Ecosystems: Interactions, Energy and Dynamics ESS3 -Earth and Human Activity ETS2 -Links Among Engineering, Tech, Science & Society CCSS (HSN. Q.A.1-3) -Define appropriate quantities for the purpose of descriptive modeling. -Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	How can we improve our model so that it produces an output that comes closer to describing our experience with the real world? What do we need to change and add? Does the acidification of ocean water affect the organisms at higher trophic levels, for instance reef fish? What policy or policies can be implemented to change the behavioral mode from what is feared, to one that is hoped for? What are the similarities between a cooling cup of coffee and last year's flu outbreak at your school? Can you find a "tipping point" where the system collapses? How could you make your model more resistant to change?

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