Using the 5E Instructional Framework

This set of lessons will provide an entry into the world of computer-based scientific modeling. Using an online application that employs block based programming, students will develop these models by engaging with the science behind water movement and the dynamics of oil in the marine environment. The lessons use a 5E learning cycle progression first developed in 1987. The theory underlying the framework views learning as dynamic and interactive. Individuals redefine, reorganize, elaborate, and change their initial concepts through interaction with their environment, other individuals, or both. The learner "interprets" objects and phenomena and internalizes the interpretation in terms of the current experience encountered (Bybee, 2015). Using the 5E Learning Cycle, the order of the activities engages students, gives them a reason to want to learn and explain the concepts, and allows them to apply what they learn prior to the evaluation.

Engage. This phase sparks students' interest and gets them thinking about the desired concept or skill. Engagements can elicit students' prior knowledge about the subject and collect information on what students know, which can be used to guide instruction. In Lesson 1, students examine the fate of bathtub toys that fell off a cargo ship and examine about a very simple computer model.

Explore. During this phase, students grapple with a problem, task, or situation in an attempt to understand the material on their own or in groups. Students can identify what they are confused about, where their ideas conflict, and what unanswered questions they may have. This phase can generate students' "need to know," and thus motivate them to find information on their own or listen more attentively and ask more targeted questions during a short lecture. In Lesson 2, students explore the properties of oil and how oil spills can be modeled. In Lesson 3, students explore the causes of ocean currents.

Explain. During this phase, students become more familiar with new ideas, terms, or ways of thinking. This can involve a short lecture, reading, or peer instruction. The aim is not just for instructors to explain, but for students to explain their understanding of a concept. In Lesson 4, students examine the features of organisms within the Gulf of Mexico ecosystem. They think about systems and how models can help us solve problems.

Elaborate. This phase requires students to apply what they have learned to novel problems or contexts. This follows the Explain phase because students' confusions and questions should have been addressed, and students need to try out their new knowledge. In Lesson 5 students work to edit a computer-based model, taking into account the new knowledge gained in lessons 2-4.

Evaluate. During this phase, students reflect on and demonstrate their understanding or mastery of concepts and skills, and instructors have opportunities to evaluate student progress toward achieving learning objectives. In Lesson 5 students collaborate to develop a computer-based scientific model that incorporates new parameters.

Bybee, R. W. (2015). *The BSCS 5E instructional model: Creating teachable moments*. NSTA Press, National Science Teachers Association.