Making Sense of Deep-Sea Phenomena

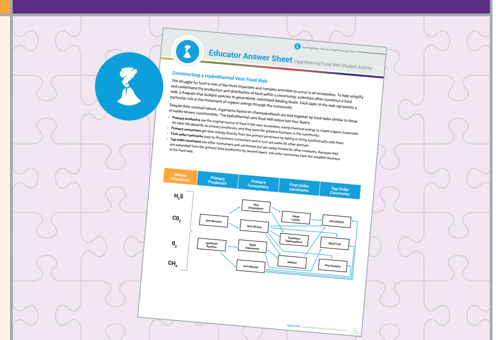
The ocean covers more than 70% of Earth's surface, yet most classroom science curricular materials primarily target terrestrial ecosystems and processes. Ongoing exploration of the ocean has uncovered complex natural phenomena, many of which are not yet completely understood. These phenomena can be used in the classroom to engage students eagerly in science learning, as well as foster their curiosity about and interest in the ocean, ocean exploration, and stewardship.

Remotely Operated Vehicle (ROV) *Deep Discoverer* shines light on a deep-sea phenomenon, like this hydrothermal vent chimney. *Image courtesy of NOAA Ocean Exploration.*

NOAA Ocean Exploration, in collaboration with the National Science Teaching Association (NSTA), has recently developed deep-sea and open-ocean classroom investigations to support the Next Generation Science Standards (NGSS) and Ocean Literacy Principles and Fundamental Concepts. The instructional approach of these investigations, known as sensemaking, reflects contemporary research on how students learn science as presented in *A Framework for K–12 Science Education*.

Sensemaking means students-as-scientists (and -as-engineers) actively try to figure out how or why a phenomenon occurs. At the start of each NOAA Ocean Exploration investigation, students are presented with an intriguing deep-sea or open-ocean phenomenon. Students' questions about the phenomenon motivate them to engage in science and engineering practices and use crosscutting concepts to build the science ideas they need to explain the phenomenon they experienced. Investigations conclude with time for students to reflect on and revise initial explanations based on gathered evidence and peer and teacher feedback. Students build new understandings as part of a learning community, but ultimately gain individual ownership of the targeted science ideas. Guidance is provided for teachers to support student sensemaking in each part of the instructional sequence (shown below). Opportunities to formatively assess student understanding—with specific "look-fors/listen-fors"—are also identified in the instructional guidance.

INSTRUCTIONAL SEQUENCE

EXPERIENCE PHENOMENON Students experience a deep-sea phenomenon and ask questions.	**INVESTIGATE** Scaffolded activities and discussions help students make sense of the phenomenon.	**PUT THE PIECES TOGETHER** Students put the pieces together and build understanding and/or reach consensus.
		
Example: *How can ecosystems survive without sunlight?*	***Example:*** *Students assemble a hydrothermal vent food web.*	***Example:*** *Students demonstrate understanding by creating a model of a live and dormant vent ecosystem.*

NOTE: The NOAA Ocean Exploration classroom investigations include a variety of scaffolds for students to support phenomena-based instruction (for example, partner conversational supports, model templates, and blank data tables). Teachers may determine that their students require more scaffolding or need fewer scaffolds to participate in the investigation. This example is from the Life on a Hydrothermal Vent Student Investigation.

SUPPORTING EQUITABLE PARTICIPATION IN SENSEMAKING

Science, technology, engineering, art, and mathematics (STEAM) subjects benefit all people; therefore, all voices should be heard and valued in STEAM. The instructional strategies described below help ensure that every student has the opportunity to share their ideas, build on others' ideas, give and receive feedback, and change their mind based on gathered evidence.

INTENTIONAL SEQUENCE OF STUDENT INTERACTIONS

Student investigations use intentional sequences of student interactions to support equitable participation and access to science learning. Interactions purposefully progress from independent thinking time in the "alone zone" to partner talk or small-group discussion, to whole-group discussion. This intentional progression helps ensure that all students' ideas are shared, built-upon, and revised based on peer and teacher feedback, with the goal of building understanding and/or reaching consensus.

ALONE ZONE	PARTNER TALK	SMALL-GROUP DISCUSSION	WHOLE-GROUP DISCUSSION
Independent thinking time provides students an opportunity to observe, question, and/or reflect.	Students share ideas with a partner to practice articulating ideas prior to sharing them with the class. Partner talk also ensures every student's ideas have been heard by at least one other person in the classroom.	Students share ideas and build on the ideas shared by their group members. When students discover they have ideas in common with their group members, it can increase their confidence.	Students contribute their ideas, their partner's ideas, and/or their group's ideas to the entire class. Students continue to build on one another's ideas, provide feed-back to one another, and have a chance to revise their thinking.

VALUING EVERYDAY LANGUAGE

Students are introduced to science and engineering language specific to deep-sea and open-ocean exploration in the NOAA Ocean Exploration investigations. However, contemporary research on language learning suggests that language is a product of science learning, not a prerequisite to learning. Students should not be expected to define science terms (academic language) at the start of the lesson or use this language without support during the investigation. When NOAA Ocean Exploration investigations are taught as stand-alone lessons or are placed at the beginning of a lesson sequence or unit, students' use of their everyday language helps ensure access to learning for all students.

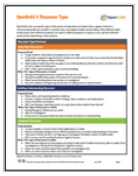
SUPPORTING MULTIPLE MODALITIES

The NOAA Ocean Exploration investigations guide teachers to explicitly encourage students to communicate their thinking using multiple means, or modalities, including talk, text, pictures, symbols, graphs, charts, and so on. As with the use of everyday language, what students communicate is elevated in importance over how students communicate their understanding. Students' strategic use of modalities can increase in sophistication over time (supported by peer and teacher feedback), but likely will not be evident over a single class period.

ADDITIONAL RESOURCES FOR SUPPORTING EQUITY IN SCIENCE EDUCATION

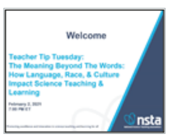
A New Vision for Science Education Infographic

Source: National Research Council



Three Discussion Types

Source: OpenSciEd



NSTA Teacher Tip Tuesday: The Meaning Beyond the Words: How Language, Race, and Culture Impact Science Teaching and Learning

Source: NSTA

Formative Assessment of English Proficiency in the Science Classroom

Source: NSTA

NOAA Ocean Exploration was established in 2001 with a mission to explore the ocean for national benefit. It is the only federally funded office dedicated to ocean exploration. Using the latest tools and technology, NOAA Ocean Exploration explores unknown or poorly known areas of our deep ocean, making discoveries of scientific, economic, and cultural value.

National Science Teaching Association (NSTA) is a vibrant community of 40,000 science educators and professionals committed to best practices in teaching science and its impact on student learning. NSTA offers high quality science resources and continuous learning so that science educators grow professionally and excel in their career.