



Engage your students in ocean exploration science

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The ocean comprises over 70% of our planet, yet it remains the most unexplored habitat on Earth. Understanding the health and resilience of our ocean is vital to our economy and survival. We depend on the ocean to regulate weather and climate; sustain the diversity of life; for maritime shipping and national defense; and for food, energy, medicine, and other essential services to humankind (NOAA). Nevertheless, the vast majority of the seafloor and overlying water column has never been seen by human eyes. Only about 15% of Earth's deep ocean is currently mapped at high resolution (Sowers, Wilkins, and Meyer 2017), and ocean science examples are rarely provided to educators and students within current science education standards.

When the *National Science Education Standards* were published in 1996, they were essentially devoid of ocean science topics. As a result, ocean concepts were not included in most K–12 classroom curricula, and we now have generations of Americans largely lacking in knowledge of the importance of

the ocean (Strang 2008). In the early 2000s, a group of marine scientists and educators collaborated with the aim of determining what students should know about the ocean by the time they graduate from high school. This effort resulted in the development of the Ocean Literacy Essential Principles and Fundamental Concepts (OLEPs) and an associated Ocean Literacy Scope and Sequence for Grades K–12 (see Resources). The seven OLEPs are now so well respected they have been adapted for use in multiple countries and translated into several languages, including Portuguese, Spanish, Chinese, Japanese, and Korean.

Considering the growing threats that the ocean faces, and the important work being done to better understand the ocean's role in sustaining life on our planet, addressing societal lack of understanding of our ocean's influence on us and our influence on the ocean is essential to human sustainability on Earth. That said, many educators continue to shy away from teaching marine concepts due to their lack of comfort with the content or connections to

existing curricula. In recent years, significant effort has been made to incorporate more ocean examples into the *Next Generation Science Standards (NGSS)* and state science standards and to encourage the inclusion of ocean concepts in current curricula. Additionally, the OLEPs have been aligned to the *NGSS*. Ocean sciences and associated ocean phenomena fit beautifully into three-dimensional learning. As educators continue to develop their skills in this arena, there is great opportunity to strengthen their understanding of ocean science topics and use this captivating environment to teach multiple subjects. A plethora of material is available that provides intriguing opportunities for teaching life science, physical science, Earth science, and engineering design and mathematics, as well as crosscutting concepts, humanities, and language arts, to engage students while using the ocean as the focal point.

Several organizations work to increase human understanding of our ocean, from shallow waters to the deep sea, by providing access to current authentic data for class-

room use, assisting educators in strengthening their knowledge, and inspiring audiences of all ages to appreciate, understand, and protect our ocean planet. The National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean Exploration and Research, Ocean Exploration Trust, and Schmidt Ocean Institute, are three U.S. organizations that, through significant collaborative effort, cultivate

substantial advances in deep-sea discovery, understanding, and action using cutting-edge technology. These organizations use complementary scientific expertise, produce innovations in exploration tools and capabilities, and provide resources and opportunities for educators, students, and the general public to engage in ocean science and exploration at sea and on shore.

Every day, ocean exploration

and the associated incredible technological capabilities are advancing the knowledge and understanding needed to help citizens, businesses, and governments make smart environmental choices, and new discoveries are captivating and inspiring current and future generations. As educators, it is our responsibility to ensure the leaders of tomorrow are well informed about the intricacies of our water planet. ●

NOAA's Office of Ocean Exploration and Research

NOAA's Office of Ocean Exploration and Research (OER) is the only federal organization currently dedicated to exploring our unknown ocean. NOAA OER works to send scientists to explore uncharted areas of our ocean, to design, test, and implement new deep-sea technologies, and to bring the wonders of ocean exploration to decision-makers, educators, students, and the general public. <https://oceanexplorer.noaa.gov>

Professional development

Free, onsite, full-day educator professional development opportunity throughout the country. Content includes the importance of ocean exploration, advanced technological capabilities used to explore the deep and open ocean, recent discoveries, and standards-based, hands-on activities and online resources for use in classroom instruction. https://oceanexplorer.noaa.gov/edu/development/onsite_development.html

Lessons/activities

Hundreds of lessons developed by ocean explorers and educators targeting grades 5–12.

<https://oceanexplorer.noaa.gov/edu/lessonplans/lessonplans.html>

All expeditions are archived with associated Expedition Education Modules designed as education packages to share the excitement of daily at-sea discoveries and the science behind NOAA's major ocean exploration expeditions. <https://oceanexplorer.noaa.gov/edu/modules/welcome.html>

Live online

Expedition Webinars for Educators introduce the science behind upcoming expeditions and associated education resources. <https://oceanexplorer.noaa.gov/edu/development/webinars/welcome.html>

Educators, students, and the general public can watch the NOAA Ship *Okeanos Explorer* expeditions live via:

<https://oceanexplorer.noaa.gov/okeanos/media/exstream/exstream.html>

Videos/blogs and more

<https://oceanexplorer.noaa.gov/image-gallery/welcome.html>

https://oceanexplorer.noaa.gov/video_playlist.html

www.youtube.com/oceanexplorergov

OER Facebook page for educators—www.facebook.com/oceanexplorationeducation

Ocean Exploration Trust

Ocean Exploration Trust (OET) is a 501(c)(3) nonprofit founded by Dr. Robert Ballard to explore the ocean, and seek out new discoveries while pushing the boundaries of STEAM education and technological innovation. This international program is launched from aboard the Exploration Vessel (E/V) *Nautilus*, and a shore-based facility at the University of Rhode Island's Inner Space Center.

www.nautiluslive.org; www.oceanexplorationtrust.org

Professional development

Educator professional development opportunities provided throughout the country as supported by program sponsors. Sign up for OET's newsletter to keep up to date with events in your area.

www.nautiluslive.org

Lessons/activities

STEM Learning Modules are a series of hands-on, inquiry-driven, standards-aligned educational lesson companions to E/V *Nautilus* expeditions. OET's Digital Resource Library supports educators with resources like warm-up activities, real-world datasets, website watch-guides, and themed video playlists for simple ways to bring exploration into the classroom. Register for FREE access to all OET materials.

www.oceanexplorationtrust.org/education-resources-access

Education fellowships

OET's Science Communication Fellowship immerses formal and informal educators and artists in the E/V *Nautilus* Corps of Exploration and empowers them to bring ocean exploration to a global audience at the Nautilus Live website.

www.oceanexplorationtrust.org/communication-fellowship,

<https://nautiluslive.org/blog/2017/10/05/stem-steam-art-aboard-nautilus>

Live online

Participate in E/V *Nautilus* expeditions and submit live questions and answers to our explorers onboard at www.nautiluslive.org

Capabilities aboard E/V *Nautilus* enable students to engage in a unique two-way, live dialogue through Google Meet with scientists, engineers, and educators of the Corps of Exploration. Twenty- to 30-minute question and answer sessions cover the latest events of an expedition and are driven by student questions. Contact education@oet.org for more information.

Videos/blogs and more

www.nautiluslive.org/photos-videos; <http://nautiluslive.org/blog>; <http://nautiluslive.org/expedition-map>

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Schmidt Ocean Institute

Schmidt Ocean Institute (SOI) is a 501(c)(3) private nonprofit foundation established by Eric and Wendy Schmidt to advance oceanographic research, discovery, and knowledge, and catalyze sharing of information about the ocean. SOI explores the global ocean, providing state of the art operational, technological, and informational support to pioneering marine scientists, engineers, and students. <https://schmidtocean.org>

Lessons/activities

The R/V *Falkor* inspired three lessons based on authentic research conducted onboard using data that have been collected by scientists at sea. Lessons are aligned to the *Next Generation Science Standards* and the *National Science Education Standards*. <https://schmidtocean.org/education/rv-falkor-inspired-lesson-plans>

Live online

Sign up for live ship-to-shore connections with your classroom during expeditions at <https://schmidtocean.org/education>. Watch archived remotely operated vehicle dives at www.youtube.com/user/SchmidtOceanVideos.

Artists at sea

The SOI Artist-at-Sea program brings artists of broad disciplines onto expeditions to work together with scientists and crew to take inspiration from the research occurring aboard R/V *Falkor*. An open call occurs every December at <https://schmidtocean.org/apply/artist-residency-program>. The work is showcased through traveling exhibits and can be viewed at <https://schmidtocean.org/collection/artist-at-sea>.

Videos/blogs and more

<https://schmidtocean.org/cruises>; www.youtube.com/user/SchmidtOceanVideos/videos

REFERENCES

National Oceanic and Atmospheric Administration [NOAA]. Office of Ocean Exploration and Research. About the NOAA Office of Ocean Exploration and Research. <https://oceanexplorer.noaa.gov/about/welcome.html>.

Sowers, D.C., J. Wilkins, and J. Meyer. 2017. Ocean mapping: an essential part of ocean exploration, NOAA OER mission log. <https://oceanexplorer.noaa.gov/oceanos/explorations/ex1703/logs/>

mar11/welcome.html.

Strang, C. 2008. Education for ocean literacy and sustainability: Learning from elders, listening to youth. *Current: The Journal of Marine Education* 24 (3): 6–10.

RESOURCES

NOAA education resources—www.noaa.gov/education/education-resource-collections

Ocean Literacy Essential Principles and

Fundamental Concepts—<http://oceanliteracy.wp2.coexploration.org>

Ocean Literacy Scope and Sequence for Grades K–12—<http://oceanliteracy.wp2.coexploration.org/ocean-literacy-framework/conceptual-flows2>

Smithsonian Ocean Portal, Smithsonian Institution—<https://ocean.si.edu>

The Bridge: An ocean of teacher-approved marine education resources—<http://web.vims.edu/bridge/?svr=1>