current
THE JOURNAL OF MARINE EDUCATION

Surfing the Wave to Online Learning with the Sea Earth Atmosphere Curriculum

REVIEWS OF BOOKS OR OTHER MEDIA

EMILY E. SESNO
KANESA DUNCAN SERAPHIN
JUDITH D. LEMUS
*Author affiliations can be found in the back matter of this article

ubiquity press

ABSTRACT

The ocean is vital to the health of the planet and plays a critical role in understanding climate change. The Next Generation Science Standards (NGSS) and Ocean Literacy Principles (OLP) establish a baseline to help incorporate ocean science into K-12 curriculum. And with the recent adoption of NGSS in many states, there is an increased need for updated material, aligned with standards, that address ocean and environmental concepts. It is also essential for students to understand ocean concepts in order to build their overall scientific literacy. The Sea Earth Atmosphere (SEA) curriculum is framed around both the NGSS and the OLP to aid teachers in including hands-on, aquatic-based content in their classrooms. The SEA website is an online platform for grades 3–5, with activities designed for both student and teacher use, including background content and instructional guides. This article describes our process in structuring the curriculum around the NGSS framework; aligning selected ocean and environmental concepts to NGSS performance expectations; and developing a user-friendly online platform with activities that facilitate educator feedback and interaction in addition to employing readily available and earth-conscious materials.

CORRESPONDING AUTHOR:
Emily E. Sesno
University of Hawai'i at Mānoa, US
sesno@hawaii.edu

KEYWORDS:
Ocean Literacy; NGSS; STEM Education; Online Learning; Elementary Education; Curriculum

TO CITE THIS ARTICLE:
Sesno, E. E., Seraphin, K. D., & Lemus, J. D. (2022). Surfing the Wave to Online Learning with the Sea Earth Atmosphere Curriculum. *Current: The Journal of Marine Education*, 36(1), pp. 51–58. DOI: https://doi.org/10.5334/cjme.73

INTRODUCTION

From puddles to lakes to the vast ocean, water is an essential component of our planet—with photosynthetic plankton contributing half of the oxygen in our atmosphere (Falkowski 2012). Despite this, students around the world have limited exposure to ocean and aquatic sciences. In fact, prior to the development of the Next Generation Science Standards (NGSS), there was little mention of ocean and aquatic sciences in United States K–12 content standards (Schoedinger et al. 2010). This neglect is remarkable because the ocean alone covers more than 70% of the planet's surface. And yet, considering that 60% of people globally do not live near the coast, the lack of awareness of ocean concepts in K-12 science education is not so surprising. Even in coastal and island locations like Hawai'i, only 66% of households have one or more members involved in ocean swimming (Hamnett et al. 2006). The result is that many students lack the opportunity to explore the marine environment, even in communities where the ocean is nearby and connection to place is central to local culture.

The Sea Earth Atmosphere (SEA) curriculum (Figure 1) was developed to enhance Hawai'i and Pacific based elementary (grades 3–5) students' ocean literacy by bringing easily accessible water science into classrooms and homes. The original SEA curriculum was published as a collection of online PDFs in 2012 and aligned to the Third State of Hawai'i Content and Performance Standards (HCPS III). Almost 200 teachers across Hawai'i were trained to use the SEA curriculum, but a mechanism did not exist for moving beyond HCPS III and shifting to the phenomenon-focus of NGSS, which were adopted by the Hawai'i Board of Education in February 2016 (with the intent of being fully implemented in schools by the 2019–20 school years). In 2022, efforts are continuing to fully implement NGSS in Hawai'i.

Figure 1 The SEA Homepage. The SEA curriculum home page provides access to content and activities by grade level and by standards alignment. Users can also navigate to the educator community (once logged on), advanced search, the original SEA curriculum PDFs, or related grade 6–12 curriculum.

We (the authors) began updating the SEA curriculum in 2017 to align with NGSS and to connect with the Ocean Literacy Principles (OLP), with examples that would not only ressonate with Hawai'i educators but also be useful for educators across the world. The OLP consist of seven core principles, associated fundamental concepts, and a grade-band scope and sequence (National Marine Educators Association 2010). In developing the updated SEA curriculum, we endeavored to make ocean science accessible to teachers and engaging for students by revising and adding activities to address the national NGSS and the international OLP. In addition, we updated the curriculum to be more interactive, with an online environment designed to enhance access to activities by in-school and at-home educators and learners. We modeled the new SEA online structure after the Grade 6–12 Exploring Our Fluid Earth curriculum (EOFE; www.exploringourfluidearth.org), which was developed over an iterative research, development, and implementation process, using results from teacher participant surveys (Curriculum Research & Development Group 2014).

This article describes our process to 1) structure the curriculum around the NGSS framework 2) align selected ocean and environmental concepts to NGSS performance expectations (PE's) and 3) develop a user-friendly online platform that facilitates educator feedback and interaction as well as employs readily available and earth-conscious materials for activities.

STRUCTURING AROUND NGSS

The SEA website (www.seaearthatmosphere.org) is an online platform with activities designed to be used by both students and teachers, including background content and instructional guides. Each grade level (3, 4, and 5) has a unit corresponding to NGSS's Earth and Space Science (ESS), Life Science (LS), and Physical Science (PS), which reflect the NGSS Disciplinary Core Ideas (DCI).

Units begin with an introduction that describes the relevant NGSS learning goals. The introduction also connects these learning goals to the OLP. Units consist of topics that cover one or more NGSS Performance Expectation (PE). Topics contain photos and visuals written at an educator level, which are intended to provide helpful background information. The three dimensions of NGSS; DCI, Crosscutting Concepts (CC's) and Science and Engineering Practices (SEP's) are addressed at the activity level with linking sentences that highlight how the activity addresses each dimension. For example, students address cause and effect in the Eroding Beaches Activity by investigating the influence of waves on a beach. We shared this activity at the Kauaʻi 2022 Youth Climate Summit; students commented that they could, "see how paddling faster makes more waves and more sand erosion" (Figure 2).

Figure 2 Example Activity Eroding Beaches. The SEA 3rd grade physical science topic on the forces of waves addresses NGSS Performance Expectation 3-PS2-1 and OLP 2. In the activity on Eroding Beaches, students explore the effect of wave forces on sand movement, which is linked to corresponding NGSS practices, crosscutting concepts, and DCI. (http://manoa.hawaii.edu/sealearning/grade-3/physical-science/coastal-erosion/activity-disappearing-beaches).

Each topic has at least one associated activity written directly for student use (with teacher recommendations and suggested student responses). All activities use the same format to guide students through the investigative process. Activities begin with a phenomenon and inquiry, allowing students to reflect on their own experiences to formulate and answer questions that help make sense of their world. For example, in the grade 5 Physical Science activity "Reappearing Salt," the PE (5-PS1-1) is to develop a model to describe that matter is made of particles too small to be seen. Students begin their investigation with the phenomenon that their skin stays salty after swimming in the ocean. Teachers can use the phenomenon and background content to introduce the investigation in their own teaching style—which might include alternate examples for students in non-coastal areas, like swimming in a sulfuric hot spring or a chlorinated pool. Students engage in the activity by creating a saltwater mixture and evaporating the water to uncover the remaining salt particles. Each activity also has guiding questions, materials (including student worksheets and teacher guides), procedure, and end-of-activity questions (Figure 3). Student worksheets are printable versions of the procedure and activity questions, providing an opportunity for assessment of student learning. On the worksheets, students reflect, record data, and answer questions. The corresponding teacher guide is a student worksheet with additional notes and example responses.

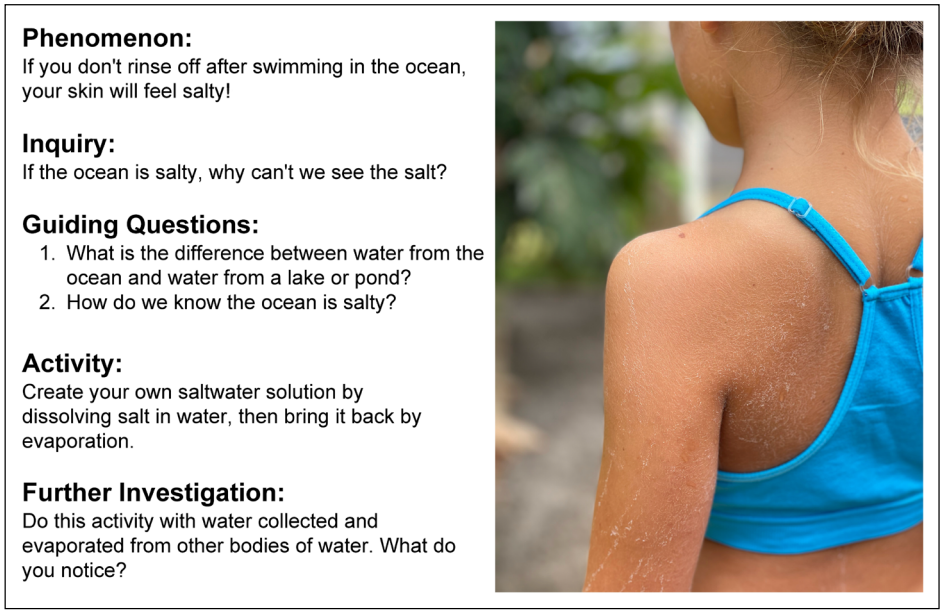

Figure 3 Activity Structure Reappearing Salt. Each activity follows the same format, guiding students through the investigations from phenomenon to inquiry to guiding questions to the activity itself (including materials, procedure, and activity questions). In some cases, Further Investigations are included at the end of the activity. (http://manoa.hawaii.edu/sealearning/grade-5-physical-science-topic-2-activity).

Each topic and/or activity also contains additional student learning opportunities, such as traditional ways of knowing, videos (e.g., 30-min Voice of the Sea episodes linked to content; www.voiceofthesea.org), National Estuarine Research Reserve (NERR) content, and Further Investigation suggestions. In the activity "Reappearing Salt," students are encouraged to continue their exploration in a follow-up Further Investigation that prompts them to widen their search to include water samples from the ocean or other nearby bodies of water (Figure 3). This Further Investigation engages students in authentic learning experiences (Reeves et al., 2002) and problem solving (Bell, 2010), and provides an opportunity for higher-level assessment by having students apply skills learned in the activity to real-world contexts.

ALIGNING OCEAN SCIENCE CONCEPTS WITH NGSS PE

Although the NGSS call for the learning of aquatic science as an essential component to understanding interdisciplinary concepts, aligning NGSS and OLP together is a nuanced task because there is not a direct one-to-one correspondence between the two standards. The Alignment of Ocean Literacy Framework facilitates connections by highlighting critical points in the NGSS where the ocean needs to be integrated in order for science concepts to be fully understood (Strang et al., 2015). The Alignment also provides tools to address examples, gaps, and inaccurate representations of ocean science in the NGSS. We used this alignment in revising the SEA curriculum in order to target the NGSS standards where understanding the OLP is essential for scientific literacy and where the OLP and NGSS have clear connections.

For example, in grade 5 Earth and Space Science, the NGSS PE (5-ESS2-1) states that students "develop a model using an example to describe ways the geosphere, biosphere, hydrosphere,

and/or atmosphere interact." We connected this PE to Ocean Literacy Principle 3, "The ocean is a major influence on weather and climate," which has parallel language emphasizing the interaction of the ocean (part of the hydrosphere) and atmosphere. In the SEA activity, "Simulating Sea Level Rise," students model and compare the melting of icebergs and glaciers to demonstrate the interaction of the warming atmosphere with the resulting rise of sea level in the ocean hydrosphere. Understanding this ocean concept is needed to fully master the NGSS PE.

In grade 3 Physical Science, the alignment between NGSS and the OLP is more subtle. The PE is to "Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object." This standard does not specify ocean concepts, however, the idea can be explored through the well recognized phenomenon of the effect of wind on the movement of sailboats using the SEA activity, "Sailing by the Force of the Wind." This activity also emphasizes the significance of sailing as a means of important cultural and historical transportation as well as modern recreation. The activity corresponds to OLP 6, concept C, that "The ocean is a source of inspiration, recreation, rejuvenation, and discovery. It is also an important element in the heritage of many cultures."

DEVELOPING A USER-FRIENDLY ONLINE PLATFORM WITH ACTIVITIES THAT EMPLOY READILY AVAILABLE AND EARTH-CONSCIOUS MATERIALS

The updated, online SEA curriculum transforms the original PDFs into a format that can be readily searched, explored, and utilized without having to download a large number of documents. The activities are searchable by standard and there is also an Educator Community element, which allows educators to review, rate, comment, provide insights, and connect with each other. At the bottom of each content and activity page, users (who are logged in to the site) can make comments, start a conversation, or ask a question. Comments can be tagged with a variety of labels, like assessment or supplies, and attachments such as images, worksheets, translations, or extensions can be uploaded and shared. Comments are also colated together in the SEA Educator Community (Figure 4). The intent of the community is to encourage educators to collaborate as they implement, modify, and extend the resources to bring meaningful lessons to their students. This type of interactive community is an important aspect of online learning, giving teachers an opportunity to connect, exchange ideas, and grow (Shaffer 2020).

Figure 4 Online Community Recent Conversations & Reviews. Users can comment on topic pages, rate activities, and upload their own resources. To view the community, users need to be logged in, but creating an account is free. (http://manoa.hawaii.edu/sealearning/sea-educator-community).

One of the aspects we are interested in researching is the adaptation of suggested supplies. In our current world of increased at-home-learning, many students do not have access to typical science classroom supplies. And, even for students learning in-person at school, availability of supplies is not guaranteed. We worked to develop SEA activities to utilize commonly found items, recycled materials, or inexpensive objects. For example, in the 3rd grade, Earth and Space Science topic on Weather Patterns, students "Model the Wind and Clouds" using a long shallow container, paper, water, a jar, matches and ice cubes. Students then "Build a Rain Gauge" to monitor weather patterns in their area using a recycled 2L bottle, scissors, a binder clip, small rocks, a ruler, and a permanent marker. Common household materials, like those shown in Figure 5, are suggested, but students are also encouraged to explore additional design ideas with whatever supplies they have accessible. For example, while testing these activities, we used several tray types (refrigerator, shoe box, baking pan), paper (paper towels, tissue, printer paper), and several clear, recycled bottles (soda, water, vinegar, oil). We anticipate that contributions to the educator community will provide valuable suggestions for alternative supplies; for example, we received queries from educators for the DIY Beeswax Wraps Activity about the use of fabric paint and left-over soy candle wax (see Figure 4).

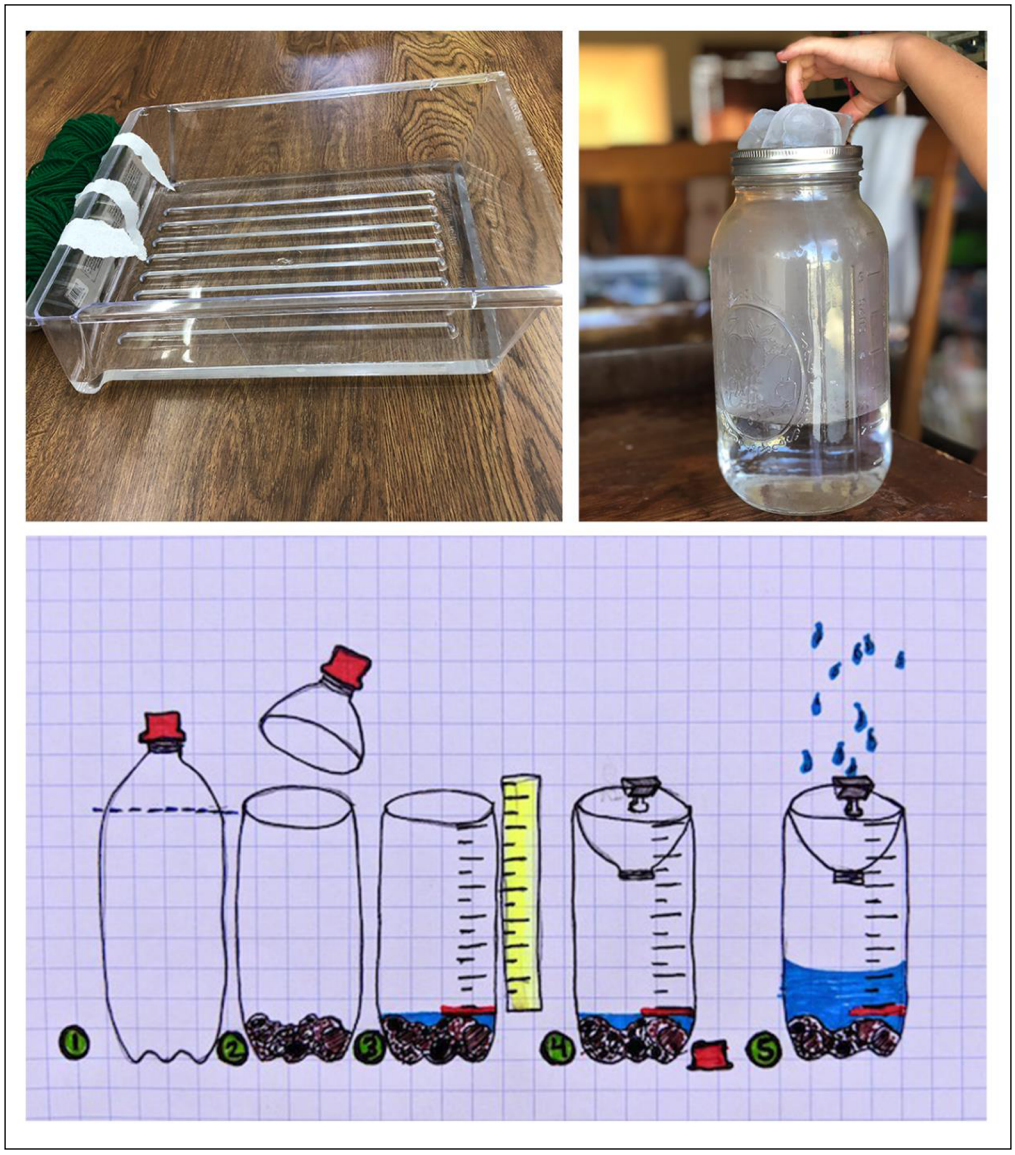

Figure 5 Example Materials in Weather Patterns. Commonly available materials are used in SEA activities. To model the wind and clouds as well as make a rain gauge, 3rd grade students use plastic trays, strips of paper, tape, ice, hot water, rulers, rocks, and upcycled 2L bottles. (http://manoa.hawaii.edu/sealearning/grade-3/grade-3-earth-science/grade-3-earth-science-topic-1).

CONCLUSION

Ocean literacy is defined as "an understanding of the ocean's influence on you and your influence on the ocean" (Carley et al. 2013). Like scientific literacy, ocean literacy extends beyond facts to the application of knowledge in everyday life. With the lack of emphasis on aquatic and marine science in previous standards, motivation for teachers to help students achieve ocean literacy was limited. The NGSS greatly improve on this by calling for the includsion of aquatic science as

an essential component to understanding interdisciplinary concepts. As such, the NGSS have paved the way for inclusion of ocean and aquatic sciences in classrooms across the nation—as well as new approaches to access content.

The ocean regulates our weather and climate. It supplies foods, medicines, minerals, and energy resources. Current world problems, such as global climate change and collapsing world fisheries, are tied to ocean processes and have local and global implications. Understanding the mutual influence between the ocean and humankind is critical to scientific and global literacy. Resources such as the SEA curriculum are needed to help teachers access high-quality lessons and implement the NGSS while addressing the critical need for improved ocean literacy in Hawai'i and beyond. We look forward to continued evaluation and improvements to the SEA resources as educators contribute to the online community and help to evolve the curriculum.

FUNDING INFORMATION

The curriculum and research presented on this website, as a revision of the original SEA materials, was supported by the National Oceanic and Atmospheric Administration (NOAA) through Grant NA14OAR4170071 to K. Duncan Seraphin and the University of Hawai'i Sea Grant College Program. The opinions expressed are those of the authors and do not represent views of NOAA or Sea Grant.

ACKNOWLEDGEMENTS

We acknowledge K. Llanos for activity testing and H. Richman and R. Nakama for website development. We also acknowledge the original SEA Curriculum content authors (Manning, M., Dale, J., Rivera, M., and Kaneshiro-Pinero, M.); activity authors (Inouye, A., Yagi, E., Umeda, K., Murakami, C.); and content editors (Fox, B.K. and Rivera, M).

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTION

All authors contributed to the conception, writing, and reviewing of this manuscript and have approved the submission.

AUTHOR AFFILIATIONS

Emily E. Sesno orcid.org/0000-0002-5848-0153
University of Hawai'i at Mānoa, US

Kanesa Duncan Seraphin orcid.org/0000-0001-9961-5782
University of Hawai'i at Mānoa, US

Judith D. Lemus orcid.org/0000-0001-6056-1262
University of Hawai'i at Mānoa, US

REFERENCES

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future, The Clearing House. 83:2 (39–43). DOI: https://doi.org/10.1080/00098650903505415

Carley, S., Chen, R., Halversen, C., Jacobson, M., Livingston, C., Matsumoto, G., … Wilson, S. (2013). *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages (2 ed.)*. Washington, DC: National Oceanic and Atmospheric Administration.

Curriculum Research & Development Group. (2014). Accessible professional development for teaching aquatic science inquiry: final report. Curriculum Research & Development Group, University of Hawai'i at Mānoa. Honolulu, Hawai'i. https://manoa.hawaii.edu/crdg/wp-content/uploads/TSI-CRDG-final-report-Secured-Final-Version.pdf.

Falkowski, P. (2012). Ocean Science: The power of plankton. *Nature*, *483*, S17–S20. DOI: https://doi.org/10.1038/483S17a

Hamnett, M., Liu, M., Johnson, D. (2006). *Fishing, ocean recreation, and threats to Hawaii's coral reefs.* Social Science Research Institute, University of Hawai'i at Mānoa, Hawai'i: 6 pp.

National Marine Educators Association. (2010). Special Report #3. Eds. Strang, C, and Tran, L. Ocean Literacy Scope and Sequence For Grades K-12. www.coexploration.org/oceanliteracy/NMEA_Report_3/NMEA_2010.pdf.

Reeves, T., Herrington, J., & **Oliver, R.** (2002). *Authentic activities and online learning.* In: HERDSA 2002 Quality Conversations, 7–10 July 2002, Perth, Western Australia pp. 562–567.

Schoedinger, S., Tran, L. U., & **Whitley, L.** (2010). From the Principles to the Scope and Sequence: A brief history of the Ocean Literacy Campaign. NMEA Special Report #3, 2009. https://www.marine-ed.org/ocean-literacy/special-report.

Shaffer, J. (2020). How to Utilize an Online Community for Teachers. Graduate Programs for Educators: Online Blog. https://www.graduateprogram.org/2020/01/how-to-utilize-an-online-community-for-teachers/.

Strang, C., Halversen, C., Holland, K., Schoedinger, S., Weiss, E., & **Payne, D.** (2015). Alignment of Ocean Literacy Framework to the NGSS for Grades 3–5. www.marine-ed.org/ocean-literacy/ngss-alignment.

TO CITE THIS ARTICLE:
Sesno, E. E., Seraphin, K. D., & Lemus, J. D. (2022). Surfing the Wave to Online Learning with the Sea Earth Atmosphere Curriculum. *Current: The Journal of Marine Education*, 36(1), pp. 51–58. DOI: https://doi.org/10.5334/cjme.73

Submitted: 04 October 2021
Accepted: 05 September 2022
Published: 16 December 2022

Current: The Journal of Marine Education is a peer-reviewed open access journal published by Ubiquity Press.