THE OFFICIAL MAGAZINE OF THE OCEANOGRAPHY SOCIETY

Oceanography

DOI

https://doi.org/10.5670/oceanog.2018.123

SIDEBAR

Seastate: Experiential C-STEM Learning Through Environmental Sensor Building

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Students at Clallam Bay School on the Olympic Peninsula are mentored by Seastate science instructor Kevin Eyer as they try soldering for the first time during building of a temperature sensor. *Photo Credit: D. Kelley, University of Washington*

A new experiential learning program called "Seastate" (http://seastate.ocean.washington.edu) has been established at the University of Washington (UW) to increase K20 (K12 plus higher education) computing, science, technology, engineering, and math (C+STEM) knowledge. The program's objectives focus on student-driven design, building, and implementation of sensors to address locally relevant environmental problems. In partnership with the West Sound STEM Network and with funding from the State of Washington, the goal is to mentor K12 teachers from 18 school districts on Kitsap Peninsula, Washington, in sensor building and marine science. In addition, the UW School of Oceanography curriculum includes a hands-on Ocean Technology program (https://www.ocean.washington.edu/story/OTP_Home) that includes a multiyear class sequence and opportunities for UW students to mentor K12 teachers and students in environmental sensing, augmented with core knowledge about local marine environments directly impacting their communities. Our experience shows that coupling hands-on activities with deployment of sensors in the field is a particularly effective way to promote computational skills and environmental literacy among underrepresented minority communities.

K12 teachers and students gain C+STEM skills and confidence by constructing their own inexpensive environmental sensors. They initially assemble temperature sensors and install them in local environments to learn the basics of sensor building, circuitry, and microprocessor functions used to assess environmental variability across a range of timescales. Other instruments include sensors for measuring light penetration through water and vegetation and for colorimetric pH assays; webcams for quantification of animal activities and distributions; weather sensors for measurements such as UV index, barometric pressure, and relative humidity; and GPS position sensors. This program introduces teachers and students to microcontroller hardware and sensor interaction via Python, which is used across all levels of computing, from microcontrollers in embedded systems to high-level scientific computing.

As part of this effort, elementary students used their sensors to monitor temperatures in a classroom tank containing salmon fry and in a local creek so that they could release the salmon under similar environmental conditions. Similarly, sixth grade students deployed temperature sensors and collected dissolved oxygen, pH, turbidity, and flow rate data on a nearby creek for comparison with earlier data to understand how this habitat has changed over the past 15 years. Middle school students used their sensors to investigate how temperatures on land and in nearby natural bodies of water differed, enhancing understanding of ecological relationships among organisms in local ponds. High school students designed and built two moorings to carry "weatherboard" sensors for measuring light intensity and temperature from the sea surface to shallow underwater depths. These data will be used to develop models for selection of eelgrass restoration sites along Straits of Juan de Fuca shorelines. Through Seastate, student-collected data about local phenomena will be uploaded and analyzed by teachers and students across the region, creating a rich environment to interactively explore their data and share online stories about discoveries and lessons learned.

In the UW Ocean Technology program, students gain foundational knowledge of methods used to observe ocean characteristics, what sensors measure, what temporal and spatial sampling resolution is required to address scientific questions, and how these translate into sensor engineering requirements. Students gain practical engineering and project management skills that help them understand and critically assess design and execution of instrumentation, including critical path planning involving conceptual, preliminary, and final design evaluations and development of budgets and milestones. Students work individually or in teams during sensor design, construction, and testing prior to installation.

A student-designed and -built cabled observatory dubbed Exploration and Remote Instrumentation by Students (ERIS, https://www.ocean.washington.edu/story/ERIS), located off of the UW School of Oceanography dock, emulates the National Science Foundations' Ocean Observatories Initiative (OOI) Cabled Array (http://oceanobservatories.org/array/cabled-array). Similar to the Cabled Array, the sensors installed on ERIS provide continuous data streams for analysis and interpretation, with scaling opportunities to the OOI. Coupling of these programs, involving instrument design and construction, data collection, and development of data analytical and visualization skills, will place students in strong positions to take full advantage of rapidly evolving sensor and data technologies that are transforming how we monitor and interact with our dynamic planet.

ARTICLE CITATION

Kelley, D.S., and D. Grünbaum. 2018. Seastate: Experiential C-STEM learning through environmental sensor building. *Oceanography* 31(1):147, https://doi.org/10.5670/oceanog.2018.123.

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