Building Buoys for Observing and STEM Education

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Introduction

The Integrated Ocean Observing system (IOOS; www.ioos.gov) is a federal, regional and private-sector partnership working to enhance the collective, delivery, and use of ocean information in a range of applications. These include human and ecosystem health, transportation safety, commerce, fisheries and weather prediction. Data streams come from many sources, including satellites, shipboard sensors, shore-based High Frequency Radar, and moored and stationary platforms.

This session presents results of a January '09 workshop that introduced the construction of an observational buoy as a "hook" for undergraduate and precollege students to become engaged with ocean sciences. The Basic Observational Buoy (BOB) workshop was a pilot event with outcomes still emerging.

Working with, and jointly funded by National Oceanographic and Atmospheric Administration (NOAA) and the National Science Foundation, the NOAA Chesapeake Bay Office, the Center for Ocean Sciences Education Excellence SouthEast (COSEE SE) and the South East Coastal Ocean Observing Regional Association (SECOORA) developed and implemented a pilot workshop to explore the outreach applications of the construction of an instrumented buoy. The workshop was designed to evaluate the potential of a Science Technology Engineering and Math (STEM) experience for precollege and undergraduate students. The instrumented buoy, while small, is a credible tool for collecting continuous data in fairly calm, protected waters for limited amounts of time. This workshop was the first stage of this process and was designed to introduce the concept to southeastern, regional scientists and educators already familiar with ocean observing information. This project addressed technology and engineering used in oceanographic investigations and monitoring systems. The focus was on constructing a platform to and sensors and data loggers that collect continuous environmental data.

National reports on education indicate the importance of developing the next generation of scientists and engineers (1,2). This requires increased focus on precollege preparation and student interest in math and science. High school and middle school science

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teachers are challenged to present STEM projects for their students. According to the 2008 article in *Education Week* (2), educators are taking advantage of increased STEM-related competitions. An interdisciplinary approach gets beyond narrowly focused subject-matter silos and "infuse(s) technology directly into the teaching of science and math courses, rather than to provide technology instruction to aspiring educators in a vacuum (page 4)."

Background

In prior projects, Doug Levin of NOAA's Chesapeake Bay Office Office developed a program where participants as young as pre-teen can design, build and launch a working underwater robot (Remotely Operated Vehicle) in less than 2 hours (Levin, et al, 2007) . Finding considerable support and excitement with this venture, he then developed two model floating instrument platforms, constructed of polyvinyl chloride (PVC) tubing, large enough to accommodate a multi-sensor package. One model became the Basic Observation Buoy (BOB)--a floating buoy anchored to the bottom. The other became the Fixed Local Observations (FLO)--a package fixed to a piling or dock structure. BOB and FLO can collect weather and water quality data in shallow, protected areas of bays, creeks and estuaries.

The BOB/FLO workshop built on previous STEM related professional development workshops that COSEE SE had coordinated over the previous four years. These included the modification of the ocean observing workshop from COSEE MidAtlantic--Taking the Pulse of Our Coastal ocean (TPOCO) and three residential Institutes focused on undersea research and technology in which COSEE SE partnered with Massachusetts Institute of Technology (MIT) Sea Grant (Sea Perch ROV). In addition COSEE SE and NOAA Gray's Reef NMS partnered to coordinate a two day ROV workshop in Charleston, SC designed to encourage teachers to enter student teams in the Marine Advanced Technology Education (MATE) ROV Competition.

Metrics and Logistics

The participants were invited to attend the BOB.workshop based on their prior involvement in ocean observing systems, interest in the developing South East Coastal Ocean Observing Regional Association (SECOORA), and participation in previous COSEE SE events.

A two-day format, beginning 4:00 pm on a Thursday afternoon, and continuing through a working dinner until about 9 pm focused on buoy construction. The second day from 8:00 am until about 4:00 pm focused more on applications and possible refinements of the BOB. The agenda was developed to encourage engagement and free thinking. The format was not to proscribe a "recipe," but to develop a forum for critical thinking and problem solving.

Twenty-three people from eight southeastern universities and agencies attended the program. Participants included scientists, graduate students, outreach specialists, private industry, and a high school teacher. Participants were housed in apartments at the Skidaway Institute of Oceanography (SkIO), Savannah GA, and the meetings were held in the SkIO Library building.

COSEE SE provided funds for lodging, meals and travel as needed. In addition, COSEE SE supplied funds for the materials for the construction of the scaled down buoys and PASCO sensors.

Doug Levin from NOAA Chesapeake Bay Office in Maryland provided instructional facilitation and assembled the materials, Lundie Spence from COSEE SE provided workshop coordination, and Jim Sanders from SkIO provided the facility. Participants came from the following institutions: Jacksonville University, University of North Florida, University of Florida, Skidaway Institute of Oceanography, Savannah State University, University of North Carolina at Wilmington, Kennesaw State University, Hilton Head High School, University of South Carolina; NOAA Phytoplankton Monitoring Network, NOAA Gray's Reef National Marine Sanctuary and South Carolina Sea Grant Consortium; DownEast Instruments, Inc. Representatives came from SECOORA and COSEE SE.

Charge

The participants were charged with assessing the value of building, modifying and deploying a scaled-down buoy designed to collect pertinent water quality information in shallow (<5m) protected waters.

This effort was intended to demonstrate the transferability of a program of excellence from the NOAA Chesapeake Bay Office to the southeast. In addition, the BOB exercise was evaluated as a STEM activity that enables precollege and undergraduate students to gain a better awareness of the platforms and sensors used in the observations aggregated by SECOORA, and thus enhancing delivery of coastal ocean information for extension and education programs.

Workshop participants were expected to engage local faculty/educators/teachers to initiate and extend this workshop to undergraduate, informal students (adults or clubs) or middle/high school student project to increase understanding of coastal ocean observation and information.

Objectives

1. Construct a BOB, mount and calibrate a suite of sensors.
2. Refine the BOB design and explore the potential for wireless data transfer.
3. Initiate an informal collaboration and create a network for the application of BOBs for teaching, gathering and reporting of environmental data.

4. Enlist the SECOORA's Data Management group to develop a online support and reporting system for BOB data.

Outputs

Working in teams, twenty buoys were constructed. A suite of PASCO sensors for dissolved oxygen, pH, Temperature (water and air), and conductivity (conductivity and temp = Salinity), were installed and calibrated. During the workshop all of the participants engaged in active learning and sharing to improve the design, decide on the best sensor suite and brain-storm telecommunication potential. While each buoy shared common components--floatation, instrument box, sensors, and weather mast, there were many individual modifications to the prototype design.

Figure 1. Levin's BOB Design
Credit: D. Levin

Immediate evaluation from the participants in a reflection session at the end of the workshop revealed that the informal and collaborative format was endorsed. The individuals wanted to continue their collaboration and conduct similar workshops in their own locations. Some participants brought and shared their sensor preferences and even larger buoy models. Lively discussion addressed design, deployment, sensors, telemetry of data and outreach potential.

Outcomes

Workshop outcomes continue to emerge nine months after the event. The South Carolina high school teacher started an extra-curricular BOB Club with students working after school to construct and deploy their own BOB and retrieve water quality information. At a university summer camp targeting inner city youth, BOB became one of the activities. Outreach specialists have scaled "BOB" to an even smaller size for elementary and middle school students.

BOB concepts have been integrated into a professional development workshop and a local high school career academy. BOBs will be deployed to collect continuous water quality data in north Florida rivers. Another participant will partner with a coastal informal environmental center to use a BOB to study water quality.

The UNC-W program for rising high school seniors, *Oceans 17*, introduced the "BOB" design to construct an observation system. The group was broken up into two working teams—each with seven members. After a short lecture about Coastal Ocean Monitoring Program (CORMP) and observing the CORMP ocean buoy design, *Ocean 17* staff facilitated a discussion on the purpose, design and goals for the "BOB" and challenged the students to improve the design in regard to buoyancy, balance, meteorological data recording and data retrieving systems. So, the goal for their buoy construction was to look at existing designs and use their creativity to modify the design in hopes to make some improvements.

UNC W Oceans 17 Team 1
Credit: J. Burnett

UNC W Oceans 17 Team 2
Credit: J. Burnett

The designs of the two groups varied (see figures 1 and 2) . Each buoy was required to take a 72 hours float test before attaching any data collectors. This proved to be a wise move in that during those 72 hours nasty weather revealed only the survival of the second buoy.

Students and staff experienced technical difficulties with the sensors. However, the 14 students working on this project really enjoyed the hands-on aspects as well as the problem solving. Most of them indicated that in future programs they would like even more time to make additional modifications.

Next steps to the southeastern BOB efforts will include SECOORA online data entry options. .

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