Guide to the Elementary Basic Observation Buoy (eBOB)

Angela Bliss, COSEE SE and University of Georgia Marine Extension Service
EV Bell, COSEE SE and South Carolina Sea Grant Consortium
Lundie Spence, Ph.D., COSEE SE
Carrie Thomas, Ph.D., COSEE SE and North Carolina State University

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http://secoora.org/classroom

Table of Contents

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eBOB stability and buoyancy being tested during the eBOB construction phase.

Introduction to the eBOB Guide

We're excited that you've opened the guide and are ready to meet eBOB, an elementary basic observation buoy that can help teach science, technology, engineering, and mathematics while encouraging students to engage creative thinking, problem solving, and teamwork skills.

The Guide to the Elementary Basic Observation Buoy (eBOB) will assist with setting the stage for designing and constructing an eBOB. The guide starts with background information on buoy types and functions then moves to suggested introductory activities to launch the project. Along the way, the guide will assist in preparing and buying materials for construction and outfitting eBOBs to collect data. *The Guide to the Elementary Basic Observation Buoy (eBOB)* contains background information, material lists to assist in constructing eBOBs, supportive lessons, options to incorporate eBOB into your classroom, a glossary to enrich students' vocabulary, and buoy related resources.

The Guide to the Elementary Basic Observation Buoy (eBOB) objective is to allow teachers to align eBOB to their needs while keeping eBOB inexpensive. Teachers and educators can align the eBOB with specific national and state standards in physical, life and earth sciences. If you have a new activity, discover a different way of introducing data to elementary students, or use new equipment, let us know so we can share with others. Email COSEE SE Marine Education Specialist, Angela Bliss (acbliss@uga.edu).

In the figure above, eBOBs outfitted with student made anemometers and thermometers are tethered and deployed in a Charleston pond.

Background of the eBOB Project

Connecting students with authentic scientific research, data gathering and analyzing, and technology use are current themes in education. Ocean science engages students with coastal and marine environments and the technologies used to understand and conserve.

The Southeast Coastal Ocean Observation Regional Association (SECOORA) is part of a national network designed to monitor and analyze information about coastal waters. Using instrumented buoys, scientists are gathering continuous information about physical factors such as currents, waves, temperature, and winds and chemical factors such as dissolved oxygen, pH, and nutrients. For more information, visit the SECOORA website (http://secoora.org). The Center of Ocean Sciences Education Excellence Southeast (COSEE SE) in a partnership with SECOORA has piloted a set of buoy based activities that engage students with marine technologies allowing them to work as scientists.

The BOB (Basic Observation Buoy) project started in 2008 as a scaled-down student version capable of holding water quality sensors and weather instruments. Pictured below, BOB is constructed from 4-inch PVC pipe and fittings. The BOB project came to the southeast region through SECOORA and COSEE SE workshops and targeted middle school through undergraduate audiences. The more technical Real-time Advanced Basic Observation Buoy (RABOB) was developed at the University of North Florida and is being incorporated into graduate level projects. To allow for smaller hands to manipulate the building materials, Build A Buoy (BAB), was created which provides the opportunity for young children to build a basic buoy. Further information on BOB, RABOB, and BAB can be found on SECOORA's webpage (http://secoora.org/classroom).

From the conceptual lineage of BOB, RABOB and BAB, eBOB was born to provide elementary students with opportunities to build scientific inquiry and problem solving skills while incorporating STEM (science, technology, engineering, and math) disciplines through eBOB construction and data collection. The idea of a buoy easily built and manipulated by smaller hands, like with BAB, led to the classroom application of the elementary Basic Observation Buoy (eBOB). eBOB has been tested in elementary settings as part of the COSEE SE elementary ocean science program, Our Amazing Coast.

We hope that you and your students enjoy learning about buoys, constructing an eBOB with fellow students, and analyzing the data collected.

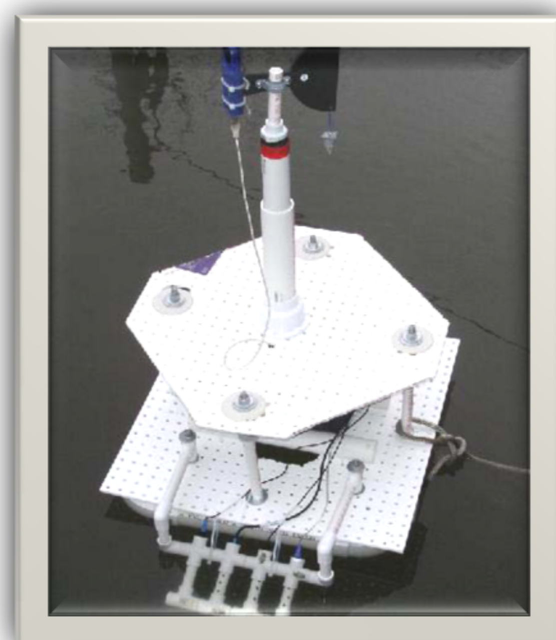


Photo credit: Doug Levin

Incorporating eBOBs into the Classroom: Standards and Options

eBOB and Standards

eBOB lessons align with many of the National Science Education Standards (http://www.nap.edu/openbook.php?record_id=4962) and the emerging Next Generation Science Standards (http://www.nextgenscience.org/), including STEM.

While state standards vary, teachers can find ways to align eBOB to the Ocean Literacy Essential Principles (http://oceanliteracy.wp2.coexploration.org/) that identify major concepts that students and adults should understand about the ocean.

Some of the principles and standards are listed below:

National Science Education Standards (NSES)

K - 4th Grade:

- Science as Inquiry
- Physical Science
- Life Science
- Earth and Space Science (Weather)
- Science and Technology
- Science in Personal and Social Perspectives

5th – 8th Grade

- Science as Inquiry
- Physical Science
- Earth and Space Science (Weather and the Ocean)
- Science and Technology
- Science in Personal and Social Perspectives

Next Generation Science Standards

The Next Generation Science Standards (NGSS) are currently under development. NGSS will be based on research from the National Research Council and based on the *Framework for K-12 Science Education*.

Ocean Literacy Essential Principles

#3. The ocean is a major influence on weather and climate. (a, b)
#5. The ocean supports a great diversity of life and ecosystems. (f)
#6. The ocean and humans are inextricably interconnected. (a, e, f)
#7. The ocean is largely unexplored. (d)

eBOB Implementation Timeline

Just like NOAA's real-time observational buoys vary in shape and size based on their function and mooring location, eBOBs differ in shape, size, and function. Below are three timeline suggestions on how eBOB can be implemented into a science class, school enrichment activity, or science club.

A. 45-Minute eBOB in a Bag

10 minutes: Introduce buoys
15 minutes: Construct eBOB in a Bag
20 minutes: ACTIVITY: *Payload Challenge* and wrap up

B. 3-Hour (Day) eBOB

15 minutes: Introduce buoys
20 minutes: ACTIVITY: *Sink or Float: Prediction/Observation Phases 1, 2, & 3*
5 minutes: Introduce materials to be used in constructing eBOB
30 minutes: Design, construct, and conduct initial float test buoys
20 minutes: Modify and retest flotation
30 minutes: ACTIVITY: *Payload Challenge*
20 minutes: Data collection equipment introduction and discussion
20 minutes: Construct data collecting equipment (if needed)
20 minutes: Deploy buoys, record data, and wrap up

C. 6-Hour (Day) eBOB

45 minutes: Weather focused Guest Speaker or Research Scientist
30 minutes: Introduce buoys
30 minutes: ACTIVITY: *Sink or Float: Prediction/Observation Phases 1, 2, & 3*
15 minutes: Introduce materials to be used in constructing eBOB
60 minutes: Design, construct and conduct initial float test buoys
15 minutes: Modify and retest flotation
45 minutes: ACTIVITY: *Payload Challenge*
30 minutes: Data collection equipment introduction and discussion
30 minutes: Construct data collecting equipment (Optional)
30 minutes: Deploy buoys and record data
30 minutes: Discuss data that were collected and wrap up

Students have selected PVC pipe sections and fittings and are testing the possibilities of how these pieces can fit together to make an eBOB.

All About Buoys: An Introduction to Buoys

What are buoys? Buoys are floating structures that come in a variety of shapes and sizes and are constructed from metal and plastics components. Some buoys are moored, or anchored to the bottom; some buoys drift with the currents.

What do buoys do?
Buoys are used in lakes, rivers and coastal and ocean waters. Buoys have various functions in navigation, data collection, and monitoring.

1. Channel markers and channel buoys prevent ships and recreation vessels from running aground or colliding with other vessels by keeping them out of shallow water. Some markers and buoys have bells, horns, lights, and other identification marks. Channel buoys are moored to the bottom and assist with navigation much like the traffic signals and signs that guide vehicle traffic on the roads. Channel markers are color coded (red or green) and can be floating or fixed. To help remember what each color means memorize the following expression: “red right returning.” This means that when returning to the harbor, the red marker should be on your right. Channel markers also assist boaters in providing information so they know their location. For more information on navigational buoys visit the United States Coast Guard website (http://www.uscgboating.org).

2. Temporary buoys, like dive flags, mark the location of scuba divers. Dive flags indicate to nearby boaters that scuba divers are beneath the water’s surface and to not approach the dive site.

3. Trap buoys mark the location of crab, lobster and other traps or pots for harvesting seafood. These colorful buoys are floating spheres that are tethered to an underwater trap, such as a crab trap, and are labeled with the owner’s information. These buoys serve dual purposes; to warn boaters of nearby traps and tether ropes so boaters can navigate safely around the gear and to provide information on who owns the trap.

4. Observational buoys are much larger than the others mentioned and can be up to 30 ft. tall! These buoys collect data with instruments attached to the structure. Observational buoys are moored to stay in place. The National Oceanic and Atmospheric Administration (NOAA) deploy and maintain buoys along the US coastlines including the Great Lakes. A great example of an observational buoy is the Gray’s Reef National Marine Sanctuary buoy that is moored about 12 miles off shore from Savannah, Georgia. Pictured to the right, this buoy, like many other observational buoys, has sensors relaying information about currents, wave height, and wind speed to shore based offices. Data collected from about 1,163 observational buoys can be found on NOAA’s National Data Buoy Center’s website (http://www.ndbc.noaa.gov).

Photo credit: NOAA NBDC

Introductory eBOB Activities

Educators often prepare students for constructing their eBOB using introductory activities to assist in building vocabulary, understanding the nature of science, and manipulating materials while focusing on making predictions and comparing these to their observations.

The following activities are found in The *Guide for the Elementary Basic Observation Buoy (eBOB)* and can be used in whole or adapted as needed.

eBOB Sink or Float: Prediction/Observation Activity

Phase 1: Buoyancy
Phase 2: Floatation
Phase 3: New Materials

Can Clay Float in Water?

Pictured above, students manipulate equal size clay pieces (one rounded in a ball and the other flattened like a pancake) so that the clay will sink or float in water.

eBOB Sink or Float: Prediction/Observation Activity
Phase 1: Buoyancy

Objective(s):
- Predict, test, and observe if objects will sink or float.
- Compare and contrast the observations.

Vocabulary:
- Float
- Buoyancy
- Prediction
- Observation

Suggested Materials:
- 1 Tall clear container (ex. Pickle jar)
- Water to fill container
- Selection of items to test, such as ping pong ball, golf ball, empty capped bottle, capped bottle full of water
- Student Worksheet
- Pencil

Procedure (Demonstration):
1. Distribute a Student Worksheet to each student or group of students.
2. Introduce the vocabulary and discuss the importance of experimenting and making predictions.
3. Place a container(s) full of water in view of all students.
4. Select items to test (ping pong ball, golf ball, empty bottle capped, bottle full of water capped).
5. First, ask student to predict if the item (e.g. a ping pong ball) will float or sink. Have students record their answers on the Student Worksheet.
6. Test the item by placing it in the container full of water.
7. Students observe and record if the item sinks or floats.
8. Repeat with other items.

Discussion:
Have students explain the difference between their predictions and the observed results. Be sure to continually emphasize that predictions can be correct or incorrect.

Have students list characteristics of items that float and characteristics of items that sink.

eBOB Sink or Float: Prediction/Observation Activity
Phase 2: Flotation

Objective(s):
- Predict, test, and observe if oranges with and without peels float or sink in water.
- Compare and contrast the observations.

Vocabulary:
- Float
- Prediction
- Observation

Suggested Materials: (Per group)
- 1 Tall clear container (ex. Pickle jar)
- Water to fill container
- Orange with peel
- Orange without peel
- Student Worksheet
- Pencil

Procedure:
1. Distribute a Student Worksheet to each student or group of students. If you did Phase 1, continue to the next step. If you did not do Phase 1, be sure to introduce the concept of a prediction (an educated guess based on current knowledge) and why testing is an important part of scientific inquiry and prediction. Predictions can be proved correct or incorrect by testing. Information is gained either way.
2. Ask students to predict if the orange with the peel will float or sink and record their answer on the student worksheet.
3. Gently place the orange with the peel in the container filled with water. Students observe and record if it sinks or floats.
4. Repeat steps 2 & 3 with the orange without the peel

Discussion:
Have students discuss their predictions versus their observed results. Did the orange with the peel float or sink? Did the orange without the peel float or sink? Why?

Have students list differences between the orange with the peel and without the peel. For instance, an orange peel holds air much like a life jacket that one wears on a boat. An orange without the peel is denser than water and sinks as it has no peel or no life jacket to increase its buoyancy.

eBOB Sink or Float: Prediction/Observation Activity
Phase 3: New Materials

Objective(s):

- Examine schedule 40 polyvinyl chloride (PVC) pipe lengths and fittings.
- Predict, test, and observe if a PVC pipe with and without end fittings will float or sink.
- Compare and contrast the observations.

Vocabulary:

- Polyvinyl chloride (PVC)
- Float
- Prediction
- Observation

Suggested Materials: (Per group)

- 1 Tall clear container (ex. Pickle jar)
- Water to fill container
- 4- inch section of ½-inch diameter schedule 40 PVC pipe
- 2 ½-inch schedule 40 PVC end caps
- Student Worksheet
- Pencil

Procedure:

1. Pass the PVC pipe section around so students can make observations and feel the PVC.
2. Based on knowledge gained through Phase 1 & 2 of the eBOB *Sink or Float Prediction/Observation Activity* or other activities, ask student to predict if the PVC pipe section will float or sink and record their predictions on the student worksheet.
3. Gently place it in the container of water. Students observe and record if the PVC pipe section sinks or floats.
4. Cap the ends of the PVC pipe section with the end caps and have students predict if the capped PVC pipe section will float or sink. Students should record their predictions on the Student Worksheet.

Discussion:

1. Discuss the students' predictions versus their observations.
2. Discuss what is different about the two PVC pipe tests. For instance, the first test involved open ended PVC pipe. The PVC is heavier then water and sank when water displaced the air in the pipe. The capped pipe held the air and kept the PVC pipe section with end caps afloat.
3. Discuss how a structure made of PVC pipe must be constructed to float.

eBOB Sink or Float: Prediction/Observation Activity
STUDENT WORKSHEET

NAME:________________________

Prediction/Observation Activity:

1) Record the object being observed and tested in the **Object c**olumn.
2) Predict if the object will float (F) or sink(S) and record your answer in the **Prediction** column.
3) Test the object in water and record your observation in the **Observation** column.

Object	**Prediction (F or S)**	**Observation (F or S)**

1. What were characteristics of items that floated?

2. What were characteristics of item that sank?

3. What did you learn about making a PVC pipe float?

Can Clay Float in Water?

Objective(s):

- Predict, test, and observe clay in water.
- Modify an object that sinks into an object that will float.
- Compare and contrast observations.

Vocabulary:

- Flotation
- Modify
- Prediction

Materials: (per group)

- 1 ball of modeling clay (golf ball size)
- Shallow container (ex. Roasting pan)
- Water to fill the container
- 20-30 metal washers or pennies
- Paper towels

Procedure:

1. Have students predict if the ball of clay will float. Then have all groups test the ball of clay by placing it in the water. Balls of clay will not float, so all groups will need to retrieve their balls of clay from the water-filled container.
2. Challenge the students to redesign the entire ball of clay into a shape that floats. Encourage the students that the clay is not too heavy and that it can be modified to float and hold weight.
3. Bring a water-filled container to the front of the class and, once teams have modified their clay ball, have them test their design in the classroom container.
4. The clay creations may still sink, but allow students to modify their design until it floats.

Discussion

What is the difference between the ball of clay and the same clay in a new design?

Extension:

Once all clay shapes float, test each team's creation to determine which shape can hold the most metal washers (or pennies).

eBOB Options: eBOB and eBOB in a Bag

eBOB: A Multi Class Buoy
Packed with discussions of weather, buoys, and data collection and supplemented with relevant activities, eBOB is an inquiry-based STEM tool focused on problem solving and experimentation that can be spread over multiple days or class periods.

Objective(s):

- Student teams design a small-scale PVC buoy based on knowledge from introductory activities.
- Student teams construct, test, and modify buoy so that it will float and hold weight.

Suggested Materials: (per class set which builds 6 buoys)

- 6 ten feet pieces of ½-inch schedule 40 PVC pipe, cut into the following sections:
    - 16 10-inch lengths
    - 32 7-inch lengths
    - 40 5-inch lengths
- 32 ½-inch S x S schedule 40 PVC 90 degree elbow
- 20 ½-inch S x S schedule 40 PVC 45 degree elbow
- 32 ½-inch 3-way S x S x S connector
- 6 full lengths of ½-inch pipe wrap or pool noodles cut into 4 to 5-inch sections
- 300 8-inch cable ties
- 300 11-inch cable ties
- 6 flying disks
- PVC cutters
- Scissors (for clipping cable ties)
- 30 golf balls

Suggested Materials: (per class)

- Plastic wading pool or a large tub at least 20 inches wide and able to hold at least 12 inches of water
- Water to fill pool
- Towels for drying wet eBOBs
- 40 sections of yarn cut into 10-inch lengths

Vocabulary

- Payload
- Platform
- Center of Gravity
- Stability
- Deploy
- Predict

Teacher Preparation:

1. Cut PVC into various lengths. Quantities of pipe lengths and fittings can vary, but offering pipe lengths and fittings in multiples of 4 is highly recommended.

2. Predrill 4 equally spaced holes in the outer rim of the flying disks, much like the cardinal direction points of N, S, E, and W. These holes should be approximately 1.5 in from outer lip of the flying disk and large enough to allow a cable tie to be threaded through the hole so that the cable ties will slide through the holes in the flying disk and wrap around the PVC pipe lengths to secure the flying disk in place.

Procedure:

1. ***Introduction Phase:*** After familiarizing students with buoy types and function, familiarize students with PVC pipe and the possible angles of attachment of the PVC fittings. Display PVC pipe lengths and PVC fittings on the table and, if needed, further discuss the PVC pieces or the angles that can be formed from the various fittings.
2. Let students know that although they must design and create a team buoy, everyone should keep in mind the limited numbers of pieces. Remind students to return PVC pipe lengths and fittings that they are not using so that others can use those items.
3. ***Design Phase:*** Have teams of students spend 15-30 minutes designing their buoy through sketching or manipulating the pipe lengths and fittings. Designs should meet the following criteria:
    a. The buoy must fit in the test tub
    b. The buoy must float
    c. The buoy must be able to carry a payload
4. ***Construction Phase:*** Once design has been approved by you and the whole team, have select team members collect the pipe lengths and fittings. Throughout this process, team members may need to return items and gather new items.
5. When the teams have constructed their eBOBs, students will test the buoys' flotation in the water-filled bin or tub. If the eBOB sinks or turns over, have students discuss and reflect on why this happened. Then students can dry off their eBOBs and return to their team tables and modify the buoys for another test.
6. Repeat testing and modifications as time and needs allow.
7. ***Payload Phase:*** After all teams have successfully built a floating buoy, distribute the flying disks and have teams decide where to attach the disk and in what orientation the disk should be positioned (ex. Concave up or concave down? Higher on the buoy or lower?)
8. Have groups attach the flying disk with cable ties (Please note: To reduce wasted supplies, use yarn or fewer cable ties to hold the flying dick in place during the test phases. When final position has been determined, then secure the flying disk with 4 cable ties.) Once again, if time allows, encourage them to try an idea and modify if needed. If time does not allow, then lead them to place the flying disk concave side up as low as possible so that the topmost part of the flying disk does not get wet.
9. Once all buoys float, have students conduct the *eBOB Payload Challenge* to ensure that the eBOB design can hold weight and remain floating upright.

Discussion

Have students talk about their design and problems that they had during design, construction, payload, and eBOB challenge.

eBOB Payload Challenge

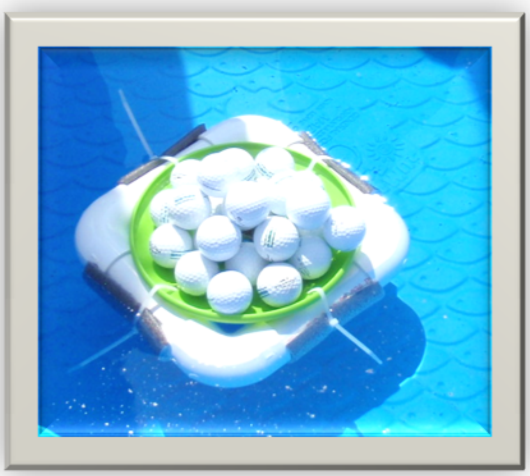
Once all eBOBs have been tested and approved for flotation and payload, then it is time for the PAYLOAD CHALLENGE! Have teams gently place their buoy in the test pool, then add one golf ball at a time to see how much payload or weight their buoy can hold. Stop counting once the buoy becomes unstable or sinks or the golf balls begin to fall off.

Objective(s):

- To determine if eBOBs can hold weight and remain afloat and stable.
- To determine which eBOB design holds the greatest number of golf balls.

Procedure:

1. Once the students place their eBOB in the water, have team members add one golf ball at a time, keeping count, until the buoy becomes unstable or golf balls fall off.
2. Record team number or name and the final number of golf balls held while buoy was stable.
3. Repeat for all teams and then discuss which design held the largest payload and why this might be the case.



Picture above, eBOB designs are being tested in stability and payload capacity during the eBOB Payload Challenge.

Using eBOB to Gather Environmental Data

Many standards for elementary grades focus on weather and the use of scientific tools. eBOBs can be used to incorporate these class standards and other STEM (science, technology, engineering, and math) disciplines into a fun hands-on inquiry project. eBOBs are meant to be cost effective and age appropriate for elementary students so the equipment used is relatively inexpensive and kid friendly.

As for data collecting locations, eBOBs can be deployed on school grounds in plastic wading pools, in schoolyard ponds, or in a nearby creek. If the eBOB is deployed in a natural setting such as a pond or creek, the buoy should be tethered for easy retrieval and security.

By attaching simple relatively inexpensive or student-crafted equipment such as anemometers, thermometers, or rain gauges, students can investigate weather or water parameters, collect data, graph data, and discuss patterns or changes in the data over their collection period. If multiple eBOBs are built, then eBOBs can be deployed to collect data in multiple locations, and the data can be collected, graphed, compared, and discussed.

Using an eBOB might provide the answers to the following questions:
- How much rain falls during a spring rain event?
- How much does the air temperature change during the school day?
- What is the average surface water temperature of a nearby pond during the month of December or May?

Objective(s):
- Discuss environmental information that eBOB will collect.
- Review how to read the selected instruments.
- OPTIONAL: Build instruments for eBOB.

Vocabulary:
- Discrete Data
- Anemometer
- Thermometer
- Rain Gauge

Suggested Materials: (per Student Team)
- 1 floating eBOB
- 20 cable ties
- 1 Student Data Collection Sheet
- Plastic wading pool or large tub
- Instrument suggestions:
  - 2 min / max thermometers
  - 1 rain gauge
  - 1 anemometer

Procedure:
1. Introduce instruments that the class will use.
   Suggested equipment:
   Thermometers: Collect temperature.
   Anemometers: Collect wind speed.
   Rain Gauge: Collect precipitation.

2. Distribute data collecting equipment to the groups and discuss each piece.
3. Have students practice reading the instrument. For example:

   MIN / MAX THERMOMETER:

   Function: Collect air and/or water temperature.

   Is the thermometer digital or traditional? If a student holds the sensor portion of the thermometer, does the temperature displayed on the instrument change? If so, what was the initial temperature and what is the current temperature? Why would outdoor thermometers be needed?

   RAIN GAUGE:

   Function: Collect precipitation.

   Add water to the rain gauge. Have students determine how much water is in the rain gauge. Also, does the rain gauge measure precipitation in inches or centimeters?

   ANEMOMETER:

   Function: Collect wind speed.

   Blow on the anemometer. Have students observe the wheel or fan rotating. If using a non digital or student made anemometer, practice calculating the speed at which the anemometer rotates. If using a store bought anemometer, read the display before blowing and while blowing.
4. Have teams collect their eBOB and discuss as a group where to attach the data collecting equipment based on the equipment's function and purpose. To avoid damaging equipment, discuss the teams' preferences for the equipment to ensure that water does not ruin electronic equipment. Distribute cable ties so students can attach equipment.
5. Check each team's eBOB to ensure that the equipment is attached safely and properly then deploy the buoys to collect data for a predetermined length of time.

Discussion:

1. Why are buoys useful platforms for scientists?

2. Why must some equipment stay out of the water?

Questions for Investigations and Discussion:

1. Does the temperature change more in air or water throughout the time data were collected?

2. Did rain fall while your eBOB was gathering data? If so, how much rain fell during the rainstorm? Did you predict more or less rain would fall during this rainstorm?

3. Did the wind blow during your investigation? Did wind speed increase, decrease, or stay the same? How fast did the wind blow?

Equipment Suggestions

Thermometers:

Digital minimum / maximum, indoor / outdoor thermometers with a probe can be purchased for $10 from greenhouse stores and home improvement stores for measuring air and water temperatures.

Indoor / Outdoor wall or window thermometers can be purchased for a few dollars and used to record air temperature.

Rain Gauges:

Plastic and glass rain gauges can be purchased from home improvement and greenhouse stores for around $3.

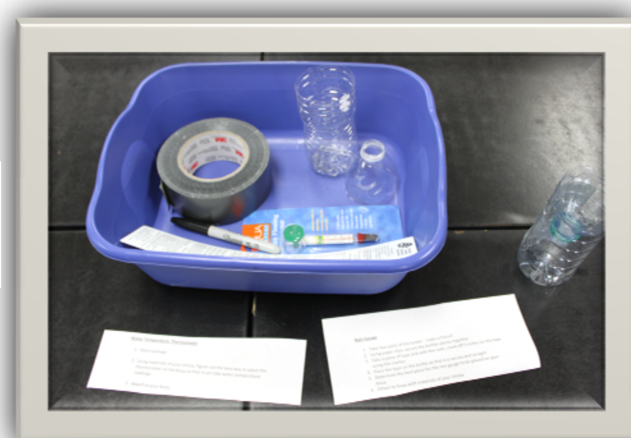
Students can make rain gauges from plastic soda bottles. Instructions can be pulled from various internet sources.

Anemometers:

Handheld anemometers can be purchased for approximately $40.

Students can make anemometers from materials like cardboard, thumbtacks, and plastic cups. Directions can be pulled from various internet sources.

Pictured to the right are supplies used during the eBOB pilot project to construct student-made rain gauges.



eBOB outfitted with student-made anemometer and air thermometer.

Student Data Collection Sheet

Group Members:____

Date Data Collected:________________________ Time Data Collected: _________________

Today's weather is: (circle one) Sunny Some Clouds Mostly Cloudy Rainy Windy

Air Temperature: ________________ Water Temperature: _________________

Rain amount:_____________ How long since the rain gauge was checked?:_______________

Any wind? If so, look at the wind vane, what direction is it blowing?_____________________
If you built an anemometer, calculate wind speed in the box below.

How to calculate wind speed from your handmade anemometer:

a. Measure the circumference of your eBOB's anemometer and record your answer.
___________ inches

b. Convert inches to feet. Divide the number of inches (answer a) by 12 and record your answer.
____________ feet

c. Divide the number of feet as recorded in the answer above by 5,280 and record your answer.
___________miles

d. To determine the number of rotations per minute, observe and record the number of rotations of the cups for one minute. Record your answer. __________ rotations per minute

e. Multiply the number of rotations per minute (answer d) by the miles (answer c) and record your answer. _______ miles per minute

f. Finally, divide the last answer (answer e) by 60 and record your answer. _________ miles per hour

Note: 12 inches = 1 foot and 5,280 feet = 1 mile

eBOB in a Bag: A 45-Minute Buoy

The full scale eBOB activity was condensed to fit into a single class period, or a 45 minute time frame, and called eBOB in a Bag. Since shortened, eBOB in a Bag introduces concepts of buoyancy, flotation, and payload, but does not factor in inquiry and experimentation in the eBOB design phase nor time for equipment discussion and data collection.
eBOB in a Bag is an abbreviated STEM based activity created for groups wanting to discuss buoys but not having the extended time required for the multi-hour and multi-day lessons. A presorted collection of PVC pieces and fittings are divided into bags and distributed to student teams following a brief introduction of buoy types and functions.

Time Frame: 45 minutes

Objective(s):
- Introduce buoys and buoyancy.
- Introduce angles and new materials for constructing buoys.

Vocabulary:
- Buoyancy
- Payload
- Flotation

Materials: (for a set of 6 eBOB in a Bag buoys):
- ½ inch schedule 40 PVC Pipe
    - 8 5-inch sections
    - 19 6-inch sections
    - 12 7-inch sections
    - 14 10-inch sections
- 8 ½-inch S x S schedule 40 PVC 90 degree elbows
- 8 ½-inch S x S schedule 40 PVC 45 degree elbows
- 2 ½-inch S x S x S schedule 40 PVC tee
- 16 ½-inch 3-way S x S x S connectors
- 3 pool noodles (cut into 4-inch lengths)
- 6 flying disks
- 25 golf balls
- Plastic wading pool or large tub
- Water to fill pool or tub
- 6 bags (grocery sacks)
- 50 8 or 11-inch cable ties

Fill bags as follows:

Bag #1: 8 ½-inch 45 degree elbows
8 5-inch PVC pipe sections
6 4-inch pieces of pool noodle

Bag #2: 4 ½-inch 90 degree elbows
4 10-inch PVC pipe sections
4 4-inch pieces of pool noodle

Bag #3: 8 ½-inch 3-way connectors
12 6-inch PVC pipe sections
4 4-inch pieces of pool noodle

Bag #4: 8 ½-inch 3-way connectors
12 10-inch PVC pipe sections
4 4-inch pieces of pool noodle

Bag #5: 4 ½-inch 90 degree elbows
2 ½-inch tees
7 6-inch PVC pipe section
4 4-inch pieces of pool noodle

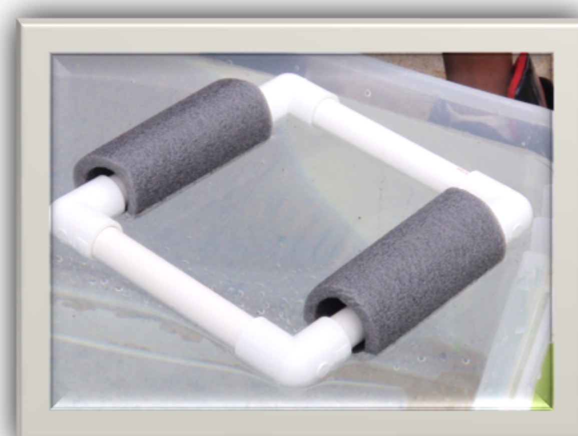
Bag #6: 8 ½-inch 3-way connectors
12 7-inch PVC pipe sections
4 4-inch pieces of pool noodle

Procedure:

1. Introduce buoys and PVC materials.
2. Divide students into 6 groups and give each group a bag of eBOB components.
3. Have students construct an eBOB with the materials provided. Students do not have to use all pieces that are provided, but each buoy must float and be able to hold the flying disk.
4. Once groups have finished constructing their buoys, have everyone gather around the tub full of water.
5. Have students gently place the team's eBOB in the water to ensure that the buoy floats.
6. If time allows, incorporate the *eBOB Payload Challenge*.
   Note: An eBOB must be able to float before attempting the payload challenge.

Students working together to create an eBOB from the bag of pieces they received.

The image to the right depicts an eBOB in a Bag being tested in a tub of water.



References and Resources

Children Literature:
Further resources range from children's publications to a buoy presentation used in elementary classroom settings. To incorporate literature into the eBOB project, elementary students might be interested in reading:

- Allain Andry's book, *Louie the Buoy: A Hurricane Story*, which tells a story of troubles and triumphs faced as Louie, a Gulf Coast buoy, battles the powerful Hurricane Camille.
- Younger students may also enjoy the fun tale by David Billings entitled *Louie the Buoy*. Although similar in name, this story is about Louie, a floating red buoy, and his life anchored offshore.

Buoy Presentation:
The Buoy Introduction Presentation as used during the eBOB pilot project is available on www.cosee-se.org and provides images and information on various types of buoys and their functions.

Journal Articles:

- Adams, L.G., Levin, D.R., and L. Spence (2012). Students Monitoring Coastal and Inland Waters with the Basic Observation Buoy (BOB). *Marine Technology Society Journal*. 46(2): 56-64
- Bliss, A. C., Bell, E.V., and L. Spence. Oranges, Flying Disks, Pool Noodles, & PVC: Oh My!. *National Science Teacher Association*. In press.

Website:

- The United States Coast Guard (http://uscgboating.org) offers resources on channel markers and navigational buoys.
- The NOAA National Data Buoy Center (http://www.ndbc.noaa.gov/) provides maps of buoy locations and real time data uploaded from the 1,100+ buoys.
- Ocean Literacy Essential Principles (http://oceanliteracy.wp2.coexploration.org/)
- National Science Education Standards (http://www.nap.edu/openbook.php?record_id=4962)
- Next Generation Science Standards (http://www.nextgenscience.org/)

Glossary

Anemometer- a device that is used to measure wind speed

Buoyancy- an object's ability to stay afloat; the upward force exerted by a fluid that allows an object to stay afloat

Center of Gravity- the point on an object at which the weight is concentrated

Deploy- to move into position and begin collecting data

Discrete Data- data collected at set intervals; data that are not collected continually

Float (or Flotation)- air filled structures used to keep heavy structures on the water's surface

Modify- to alter or change

Mooring- a permanent structure or device in the ocean or water body to which a vessel or structure can be secured in place

Observe (or Observation) – to notice or perceive

Payload- the weight or capacity of a vessel or structure

Platform- a stable framework to which equipment or items can be secured

Polyvinyl Chloride (PVC)- a widely used plastic pipe and fitting material for construction

Predict (or Prediction)- to declare in advance

Rain Gauge- an instrument used to collect and measure the amount of precipitation, typically rain

Stable (or Stability)- the ability of an object to stay in equilibrium, or steady, when disturbed

Thermometer- a device that measures temperature of air or water

Wind speed- the speed at which the wind blows