CoSEE
CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE
BEST OF COSEE HANDS-ON ACTIVITIES

Activity Title: What is in the Water?

Learning Objectives

Students will use open inquiry to learn about the process of science as well as gain experience regarding the Law of Conservation of Mass, dissolution, and density.

Ocean Literacy Principles

#1 -- The Earth has one big ocean with many features

#6 -- The ocean and humans are inextricably interconnected.

Supplies and Materials

- 25 clear vials (40 ml works well)—filled as described in Table 1. These can be glass or plastic.
- 5 mystery vials—with Tea and dirt (or a real environmental sample if colored and/or containing particulate materials.
- Tap water
- Food coloring (red, blue, yellow, green)—1 drop should color the solution brightly
- Salt—enough to taste, but not supersaturated (needs to be completely dissolved)
- Soft Soap—enough to cause a foam when shaken vigorously
- Sugar—enough to taste, but not supersaturated (needs to be completely dissolved)
- Sand—just a sprinkle that is visible to the eye
- Vinegar—enough to smell
- Dirt— enough to see
- Tea—enough to tint the water yellow

Background

Aquatic chemists study dissolved and particulate components in natural water samples to determine the level of contamination, the overall water quality, and the optical characteristics of a sample. They use simple observations and expensive analytical instruments to measure properties or chemical concentrations of major and trace components in water samples. In this activity, students will replicate the scientific process in their individual to community analysis of brightly colored water samples.

Some chemical oceanographers study colored dissolved organic matter or chromophoric dissolved organic matter (CDOM) to trace freshwater into the ocean or to track phytoplankton, bacterial, or sediment carbon sources in seawater. This activity replicates the authentic experience that these oceanographers conduct in their research.

Duration

45-60 minutes

Audience

Grades 4-8

Procedure

1) Students are placed in groups of 5.
2) As a warm up, each group receives a mystery sample (natural sample or one made with tea and dirt). Each group is given 2-3 minutes to investigate their sample with the prompt: "What is in your sample? What evidence can you gather to prove it?"
3) The instructor asks what will happen when you drop a granular substance into a vial of pure water. Students make predictions. The instructor demonstrates that sand will fall through the water and settle on the bottom. This is what happens to eroded particles as they enter the ocean by a river. The instructor asks what happens if you shake it up? The instructor then asks how much the total contents of the vial weigh—the sand plus the water. How can we get the sand out of the water? A coffee filter or other filter is usually suggested. How much will the filtered sand weigh? Usually students correctly predict that the sand will weigh the same as it was before it was added to the vial. This is an example of the Law of Conservation of Mass.
4) The instructor then asks what will happen when you drop a second granular substance into the vial. The instructor sprinkles sugar into the vial and shakes it up. Students watch as the substance falls through the water and then disappears. The instructor asks what happened? Usually someone suggests that it dissolved. Some students have never witnessed this process. The instructor asks how can we get the sugar (or salt, but sugar dissolves faster) back? Some might guess a filter, but dissolved substances cannot be filtered out of water. Someone may or may not suggest that you can evaporate the sample. This can be tried over time or on a radiator if the instructor would like. How much does the recovered sugar (or salt) weigh? Yes-it will be the same as you added originally.
5) Then the instructor asks what will happen if you place a tea bag into the water. Students witness the colored dissolved material leak into the water tinting it yellow-brown. How can we get this material out of solution? Not by filtering, but by evaporation. How much will it weigh? The original tea bag minus the dry tea bag after it was leached. So, dissolved materials can be colored.
6) Each student gets a colored vial. Each table of 5 has similarly colored vials.
7) Students are instructed to explore their vials individually. They are told that the solutions are harmless and were prepared in a kitchen. They may open the vials, sample the vials, etc, but not taste them. If you have the supplies, you can hand out and explain pH paper (litmus paper), a refractometer (that measures salinity), a coffee filter, a magnifying glass or loupe, etc. However, even simply shaking, smelling, and carefully observing is fine. What is in your vial? How can you test your hypotheses?
8) Students are asked to write down their observations, hypotheses, and tests. Students can be provided with simple water quality tests as above if available, but it is not necessary.
9) Students are then invited to share their observations with other scientists at their table (all

the same color). They will discover that while each of their solutions looks the same, they do not contain the same substances.

10) Students are the invited to share their conclusions with the entire class. Students will discover that each group of colored vials contains the same variety of substances in them. They can be told that they have just completed the scientific process—individual observation, sharing diverse observations with other researchers, coming to a community consensus on what is in the water, providing evidence for their conclusions.

11) Students are the invited to transfer what they have learned about observations, dissolved and particulate materials, the Law of Conservation of Mass, and simple tests to their Mystery Solution. The instructor can reiterate that they have done what many chemical oceanographers do for their research, although sometimes with fancy and/or expensive equipment. The instructor should not tell the students what is in the Mystery Solution when asked. Scientists do not know everything in their seawater sample. They can only perform tests and analyses and tell you their conclusions. This is the same for students and their

Mystery Solutions:

Table 1: Vial Contents

1	Red	Salt	
2	Red	Soap	
3	Red	Vinegar	
4	Red	Sand	
5	Red	Sugar	dirt
6	Green	Salt	
7	Green	Soap	
8	Green	Vinegar	
9	Green	Sugar	dirt
10	Green	Sand	
11	Blue	Salt	
12	Blue	Soap	
13	Blue	Vinegar	
14	Blue	Sand	
15	Blue	Sugar	dirt
16	Yellow	Salt	
17	Yellow	Soap	
18	Yellow	Vinegar	
19	Yellow	Sand	
20	Yellow	Sugar	dirt
21	Clear	Salt	
22	Clear	Soap	
23	Clear	Vinegar	
24	Clear	Sand	
25	Clear	Sugar	dirt

Extensions:

- Students might be invited to tour an active analytical chemistry lab to see the instruments

used to determine what is in the water.

- Students might be asked to read an article on water contamination (drinking water, river water, seawater, etc) and discuss how the scientists determined what is in the water.

Assessment

- Students can be asked to define dissolved, particulate, and the Law of Conservation of Mass before and after the activity.
- Student worksheets can be assessed for thoroughness of observations, hypotheses, and testing.

This lesson plan was provided by COSEE OCEAN. For more information, please contact Bob Chen at bob.chen@umb.edu.