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

Activity Title: The Great Plankton Race

Learning Objectives

Participants are challenged to design a planktonic organism that will neither float like a cork nor sink like a stone. They are given pictures of planktonic organisms and simple materials. The best model of a planktonic organism will sink slowly or be neutrally buoyant. After designing with their team mates, students test and race their plankton in a simulated ocean. Please note: This exercise is designed to give students an opportunity to apply observations and concepts in an engaging way. It is not a biomechanics exercise, and thus Reynolds Number issues are ignored.

Ocean Literacy Principles
#1 -- The Earth has one big ocean with many features (sub categories a, e)
#4 -- The ocean makes Earth habitable (sub categories a, b)
#5 -- The ocean supports a great diversity of life and ecosystems (sub categories a, c, d, f, h, i)
#6 --The ocean and humans are inextricably interconnected (sub categories a, e, g)

Supplies and Materials

For the class:

- water to fill aquarium
- two stopwatches
- a knife for cutting corks
- award Ribbons (See Preparation of Materials)
- 1 sheet each of red, blue and white paper
- 28 sheets yellow paper (or another color not red, blue or white)
- diversity of plankton cut out transparencies
- video and VCR or pictures of plankton (optional)

For each small group of 5-6 participants:

- one to several gallon jars or clear plastic shoeboxes (e.g. plastic mayonnaise)
- water to fill the gallon jars or plastic shoeboxes
- container or plastic bag filled with the following found materials: recycled Styrofoam packing "peanuts," corks (whole and half), toothpicks, paper clips, metal washers, colored yarn, split-shot fishing sinkers, 1" - 2" square pieces of sponge
- 2 pairs of scissors
- sponge to mop up drips

Background

This activity provides an opportunity for students of all ages to grapple with concepts relating to density, buoyancy, and surface tension. This activity can be used to initiate young children's thinking about characteristics of floating and sinking objects, or it can involve older students in exploring more complex scientific concepts about forces that counteract gravity's pull on objects. Testing objects in water will intrigue younger students who can investigate and explain it at an observational level, and it may also inspire them to explore and expand on their foundational understandings about surface tension, buoyancy, and density.

Duration

40 minutes and can be modified depending on the setting

Audience

Grades 1 -12 and can be used with adults as well. Because the activity can be approached from different levels of experience and understanding, as a facilitator it will be important to figure out "where" your students are and plan the activity accordingly. Consulting ahead of time with the classroom teacher or informal educator/coordinator can be helpful with determining this.

Procedure

Introduction to Plankton

Begin with some background information about plankton. Tools for doing this include showing a plankton video, photos of plankton and/or using plankton transparency cut-outs. This will depend on your interest and how much time you have for the activity. All tools are described below.

Plankton Video

1. Watch video. Have participants pair-up to watch a plankton videotape such as the Monterey Bay Aquarium "Treasury of Ten Aquarium Videos" (Alternatively, show photos, pictures or posters to illustrate the diversity of plankton.) Distribute one sheet of blank paper and two pencils to each pair of students.

Sidebar: This is a very cool video clip of plankton – no voice over, just a very fun and catchy musical soundtrack. Students and teachers find it intriguing and very interesting to watch.

2. Participants discuss video with partner. While watching the videotape, have participants quietly discuss with their partner what they observe. Suggest that they look at the colors, shapes, spines, and kind of motion (if video available).

3. Pairs sketch plankton. Have each pair work together to sketch at least two different plankton species as the video is playing.

4. Label sketches. After the video clip, have them label in their own words, some of the interesting features they noticed on the plankton they sketched. Remind them to again think about the colors, shapes, spines, and kind of motion.

5. Share sketches with table group. Now have them share their drawings with another pair of students. Tell them they can add to or modify their drawings based on any new information the additional pair introduces.

6. Lead class discussion and record ideas. Lead a class discussion as groups share their drawings and observations. Record their ideas on a class chart labeled About Plankton. [Some of their observations about similarities may include the following: many are transparent; lots of legs or appendages; weird-looking; spiny; weak-swimmers; red coloration; connected in chains, beating cilia (hair-like structures). Differences may include: lots of different shapes; some are stationary; some look like worms; some look like jellyfish; some have long and some short spines].

Questions to use at this stage of the activity include:

- Have you ever seen...?
- What did you observe?
- Did you notice...?

Diversity of Plankton Cut-outs

1. Show the Diversity of Plankton transparency cut-outs on the overhead projector and have participants help you find similarities and differences between all the various samples shown. Ask the question: “What do you observe?” Have participants raise their hands and then call on a few to give their ideas. Ask follow-up questions such as: “Who has a different idea?” and “Did you notice?”

2. Volunteer does secret sort of plankton. Then ask participants to think to themselves about how they might sort the pictures. After a minute or so, ask for a volunteer to do a secret sort of the pictures on the overhead and have everyone else try to guess what criteria they were using to sort. After a few participants answer, have the volunteer describe the criteria they used. Ask if anyone has a different way to sort them. Depending on time, you may have another volunteer sort the pictures.

3. Participants describe structures. Now have participants describe some of the structures they can see in the drawings. Call on a few students and have them share in words, or come up and point to the structures. [Structures they might observe include: spines, chains, hairy-looking, many legs and etc.]

4. Group discussion about benefits of structures. Then ask the question: “How might some of those structures help the plankton survive in its environment?” Have participants discuss the question with a partner, then call on a few students that raise their hands. Give noncommittal, yet encouraging responses and ask if anyone has a different idea. [camouflage, predator avoidance, prey capture, flotation.]

5. Group discussion about how to slow sinking rates. Ask: what are all the ways plankton might be able to slow down how fast they sink? Call on a few participants. Remain noncommittal, yet encouraging in your responses and ask for other ideas. [Possible answers include: flattened appendages, small bodies, long spines, gas or oil floats, chains, etc.]. Now ask a volunteer to group all of the transparency drawings together that they think show structures that might help to keep the plankton from sinking. Ask if someone would like to modify and change the sort.

6. Participants discuss benefits of slow sinking with table group. Have participants discuss the following question with their table group. “Why would flotation adaptations or at least a slow rate of sinking be important to plankton?” After a minute or so, repeat the question and call on a few participants who raise their hand. Ask for other ideas and explanations. [Phytoplankton need to stay near the surface sunlight and zooplankton need to stay near their food–¬ the phytoplankton.]

7. Lead a whole group discussion about confirming ideas. Finally, ask how they might be able to confirm their ideas about ways to slow sinking rates. [Possible answers: library research, field or aquarium observations, modeling, etc.]

Designing and Building Plankton

Fill large aquarium/tub for the race. Fill individual tubs for testing designs. Lay out building materials for students to collect.

1. Introduce activity. Tell students that each of them will now get to try out their ideas about

sinking rates of plankton. They will design and build a plankton model from materials with different densities. Show the class the materials they can use to make their plankton and the gallon jar of water they will use for their pre-race testing. Remind students that each model should be constructed to sink as slowly as possible, but must not float at the surface (in nature some plankton species do live at or on the surface, but most drift beneath it).

2. Provide directions. Tell them that they will try out how well their plankton does in their small group aquarium and then once they have made a model that they like, they will have the opportunity to race it against another student's model in the large aquarium at the front of the room.

3. Form groups around materials. Form the students into small groups gathered around a few desks pushed together. Place a pile of available materials, a gallon jar of water and a sponge in the center of each group.

4. Circulate as students work. Circulate around the room to check on the student's progress. Questions to ask at this point include:

- What happened when...?
- What did you discover?
- What do you think will happen if...?
- What questions do you have?
- What could we do to find out?

5. Lining up for race. Once an individual has made a plankton model and tested it in their group gallon jar, they can queue up behind the large aquarium at the front of the room.

6. Students explain adaptations and conduct race. Have pairs of students take turns explaining the adaptations of their plankton and then conduct preliminary heats in the large aquarium. Have two students at a time place their models just below the surface. Have two other students stand ready with stopwatches to record the time each takes to sink to the bottom of the aquarium (25 cm). At the "go" signal (consider using a toy cap pistol for effect) each contestant releases their plankton and the race is on. Have two additional students record the student's name and time on the board.

Sidebar: Starting the race with the plankton just below the surface avoids the problem of surface tension which can keep some models of plankton from sinking.

7. Conduct semi-final races. After all students have raced their plankton, select the four students with the slowest times for semi-final sink-offs. Winners of the two semi-final heats race off for the championship.

8. Students describe winning plankton's adaptations. Have the winners describe the adaptations that led to their plankton's success.

- Questions to use at this point in the activity include:
- What did you find out about...?
- How is this the same or different from..?
- Can you compare this to something else?
- What do you now know about the characteristics of...?

9. Present awards at Awards Ceremony. Have an awards ceremony and distribute cut-out paper

trophies to the slowest racers and participant ribbons to all.

10. Distribute “Features that Planktonic Organisms Share” handout.

Assessment

Have the students either say out loud (and you write their responses out on the board or paper) or have the students write down on paper one or two things they learned about plankton that they didn’t know before the class. This will give you an idea of what new information the students are taking with them.

Additional Resources:

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Bromley, K.D. *Language Arts: Exploring Connections*. 2nd Edition. Boston, Allyn & Bacon, 1992.

Cecil, N.L. (1995). *The Art of Inquiry: Questioning Strategies for K–6 Classrooms*. Winnipeg, Manitoba, Canada, Peguis Publishers.

Dillon, J.T. (1990). *The Practice of Questioning,* London, Routledge.

Gallas, Karen (1995). *Talking Their Way Into Science: Hearing Children’s Questions and Theories, Responding with Curriculum*. New York, Teacher’s College Press.

Goodlad, J. (1982) Let’s get on with reconstruction. *Phi Delta Kappan* 64, pp. 19–20.

Goodwin S, et al. (1989). Planning questions, in *Classroom Communication: Collected Readings for Effective Discussion and Questioning.* Madison, Wisconsin, Magna Publications, pp. 91–93.

Lemke, J. L. (1990). *Talking science: Language, learning and values*. Norwood, Ablex Publishing.

Thompson, A. G. (1992). Teachers’ beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning*. New York: Macmillan, pp. 127–146.

Wilen, W. W., (Ed.) (1987). *Questions, Questioning Techniques, and Effective Teaching* Washington, DC, National Education Association.

This lesson plan was provided by COSEE OLC. For more information, please contact Susan Bullerdick S.Bullerdick@seattleaquarium.org.

FEATURES THAT PLANKTONIC ORGANISMS SHARE HANDOUT

Sidebar: When going over this handout it’s helpful to include photos or illustrations of plankton that have some of the various features described.

2 themes

1. staying up in water —avoid sinking to bottom
2. avoid being lunch —avoid predators

1. small size

- Reduce sinking
- harder for predators to see and/or capture

2. spines (e.g. diatoms, crab larva or zoea, dinoflagellate), fins, wing-like body extensions (e.g. arrow worms or chaetognaths; pteropods or planktonic snails)

- increase drag like parachute, decrease sinking
- also predation defense - spines and extensions increase effective body size
- make it hard for predator to capture/eat organism

3. shell and body coverings

- have no shell – reduces weight and reduces sinking, but makes organism more vulnerable to predators
- have thin shell – add as little weight as possible

4. some ability to swim (vertical – up and down in the water)

- swim to counteract sinking
- swim to escape predators (but swimming by prey actually helps vibration-sensitive predators like arrow worms find prey)
- vertical migration
  -- swim up to surface to feed at night and down to depth during day
  -- feeding at night and hiding in darker depths during the day helps avoidance of visual predators (like larval fish)

5. high water content of body -- be as much like drop of water as possible

6. buoyancy and flotation regulation

- oil droplets – copepods store oil drops & use for energy during winter months; drops have dual purpose for energy and increase in buoyancy
- gas-filled floats -- Portuguese man of war

7. transparent, jelly-like body -- body less dense and harder for predators to see