



FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

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Ideas with

IMPACT

STEM

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The Great Plankton Races

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Florida Next Generation Science Standards:

STANDARDS SCIENCE HIGH SCHOOL:

SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: 1 Pose questions about the natural world, 2 Conduct systematic observations, 3 2 Examine books and other sources of information to see what is already known, 4 Review what is known in light of empirical evidence, 5 Plan investigations, 6 Use tools to gather, analyze, and interpret data, 7 Pose answers, explanations, or descriptions of events, 8 Generate explanations that explicate or describe natural phenomena (inferences), 9 Use appropriate evidence and reasoning to justify these explanations to others, 10 Communicate results of scientific investigations, and 11 Evaluate the merits of the explanations produced by others.

SC.912.N.3.5 Describe the function of models in science and identify the wide range of models used in science.

STANDARDS MIDDLE SCHOOL:

SC.7.N.3.2 Identify the benefits and limitations of the use of scientific models.

SC.8.N.1.2 Design and conduct a study using repeated trials and replication.

STANDARDSELEMENTARY:

SC.1.P.8.1 Sort objects by observable properties, such as size, shape, color, temperature (hot or cold), weight (heavy or light), texture, and whether objects sink or float.

SC.K2.CS-CS.1.4 Solve questions individually and collaboratively using models.

SC.3.N.3.2 Recognize that scientists use models to help understand and explain how things work.

SC.4.N.1.8 Recognize that science involves creativity in designing experiments.

Goals:

I wanted to have a project that introduces the engineering design process to my students while we are working on understanding how plankton interact in their water environment. My students were taking AICE Marine Science AS Level and during Unit 4 of our study, this hands-on-lab made it possible for them to engage with the topic in a novel way.

Students build their own plankton models through the engineering design process. An investigation and intriguing STEAM Lesson, The Great Plankton Races challenges students to design a planktonic organism that does not float or sink quickly with the best model of the plankton sinking the slowest. The student will be given a variety of household material to use to design their model. Students will work in small collaborative groups to design, test, modify and refine their models before a final elimination race in a stimulated water tank. They will review the concepts of density, buoyancy, and surface tension where younger students can differentiate between sinking and floating while older students grapple with more complex concepts about the forces of gravity and buoyancy.

Objectives:

- This lesson incorporates the engineering design process
- Students are challenged to design a planktonic organism that does not float or sink quickly
- Students with the slowest sinker or neutral buoyancy is the best model
- Students will utilize a variety of common items to build their model
- Students will Design, test, modify and refine model before racing with elimination rounds
- Students will review the concepts of density, buoyancy, and surface tension

Project Overview:

I teach 9-12. For this project, the students had a variety of materials they could have used to build their planktonic organism model. For my students, I required that they needed to use modeling clay and at one of the weighted objects (metal washer, marble, paperclips, etc.). Using either one alone would result in a model that sinks too quickly. To create a more buoyant planktonic organism, they had the following materials available: additional marbles, pieces of a pool noodle, fabric, popsicle sticks, yarn, wooden beads, paper clips, pipe cleaners, toothpicks, Styrofoam, aluminum foil and pieces of metal. Their model had to be limited by a minimum mass and a maximum volume which challenged them to design their models to meet these parameters.

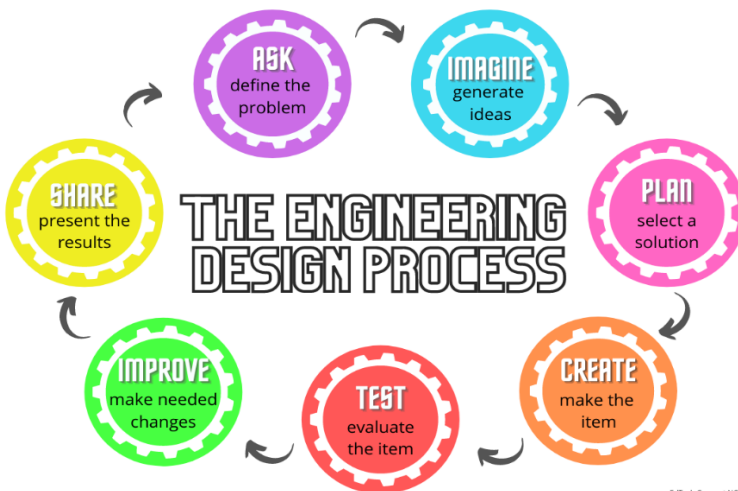
This took approximately 2 class periods, with the first focusing on the introduction to plankton, the activity, guidelines and limitations, and time to design, test, modify and redefine their model. The second class period consisted of the actual race through an elimination bracket style. After the tournament, students had to complete a lab report where they reviewed the Engineering Design Process and analyzed the concepts of density, buoyancy, and surface tension.

To make this more challenging, each item used can have a "cost" and students are limited by a "budget". To adopt this experiment to middle school or elementary school, different parameters can be implemented. Students can explore the concepts of sinking and floating, make observations, test a hypothesis, and make a simple conclusion.

Additionally, consideration to have for this project is adopting this for one to two class periods. More time will be needed for multiple rounds and giving students time for modifications and improvements utilizing the engineering design process.

Some pre-work to make this project successful would be having videos or images of plankton, allow time for students to design (sketch) their plankton before building them, providing space for think-pair-share among small groups, and class discussion before and after the activity.

A prefilled water tank and sorted materials for each group will speed the process.



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Lesson Plan:

Vocabulary for all grade levels:

- Buoyancy
- Density
- Surface Tension
- Floating
- Sinking
- Gravity

Vocabulary for High School:

- Zooplankton
- Phytoplankton
- Holoplankton
- Meroplankton
- Neuston
- Nekton
- Benthos

Materials:

For the Class:

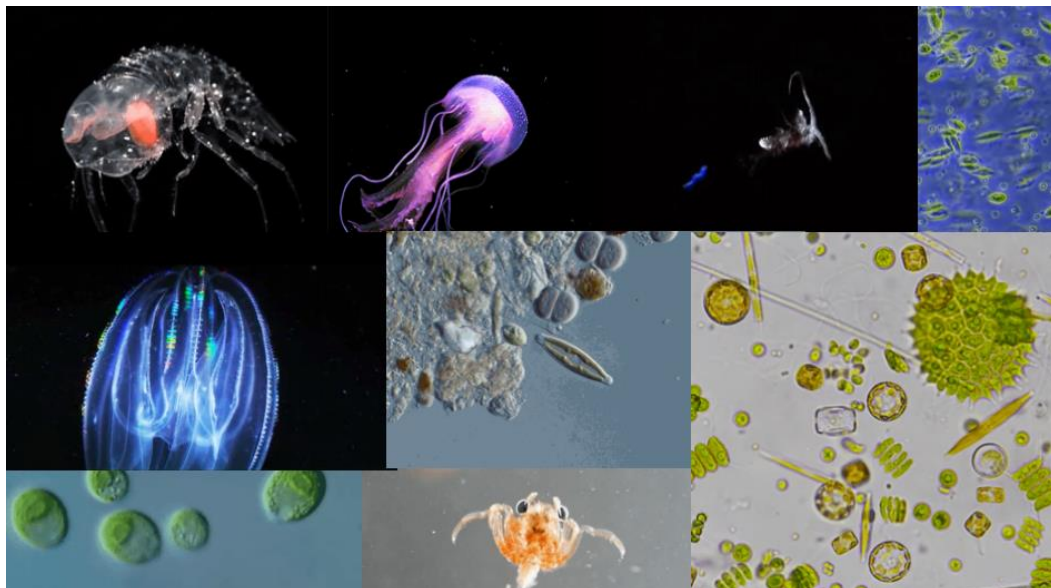
- Tank or large bin
- Timer or camera
- Utensil to cut buoyant material
- Access to bracket generator
- Scale for measuring mass
- Paper towels and Sponges for clean up

For each small group 3-5 students

- Plastic or aluminum bin
- Buoyant material
 - Cork, Styrofoam, Packing Foam, Wooden sticks, Toothpicks, etc.
- Weighted material
 - Marble, Metal washers, Ceramic Pieces, Paper clips, etc.
- Modeling clay
- Scissors

Background Information:

Review what is Plankton. Have students identify various plankton species with images or videos.



Review terms for Plankton, Nekton, Neuston, Benthos for High School

- The word “plankton” comes from the Greek for “drifter” or “wanderer.” An organism is considered plankton if it is carried by tides and currents and cannot swim well enough to move against these forces. Some plankton drift this way for their entire life cycle.
- Phytoplankton are microscopic plants
- Zooplankton are microscopic animals
- Holoplankton spend their entire life cycle as plankton
- Meroplankton spend part of their life cycle as plankton (larval stage)



Have students Think-Pair-Share the concepts of Plankton. Have them draw a model of plankton they will design with given material if time permits. If limited in time, have the students start building their plankton model with limited number of supplies giving them additional supplies as needed/available.

Have class discussion on plankton. Possible questions:

1. Why do they look that way (flat, gas-filled, protrusions)?
2. What is the importance of high surface area to volume ratio?
3. Why is it advantageous to travel with current?
4. Why would plankton prefer to move up and down the water column?

Students in K-5:

1. Task them to differentiate between floating and sinking materials by having them predict which materials will float and which will sink. Students can test their predictions whole group or in small groups
2. Limit the materials they use and have them build their model using predetermined quantities
3. They test their plankton one at a time and can measure their rate to sink. Record observations
4. Extension: Students graph the data as a bar graph

Students in 6-8:

1. Apply the terms buoyant, density and gravity to pre-lab discussion
2. Students will make a design of a model to use based on available materials
3. Students test their models in their small groups and can make refinements until the competition
4. Identify the variables and draft a hypothesis to test
5. Students record data of mass of model, time of descent, distance travelled and speed on data table. They can graph the data
6. Answer analysis questions on Engineering Design Process (i.e., why was modification necessary after an initial test?)
7. Extension: Students modify their models with a new limitation

Students in 9-12:

1. Same parameters as Middle School students
2. Can add a token economy where each material has a cost, and they have a budget to meet (real-life application)
3. Can add minimum mass requirements and mandatory weighted materials to use
4. Any plankton model that floats longer than 5 seconds is automatically disqualified
5. Add an additional material to incorporate in between elimination rounds
6. Create a full lab report of experimental design
 - a. Include the following Components:
 - b. Title: Be Creative
 - c. Introduction: Brief background information with objective and variables
 - d. Hypothesis: should be a statement starting with “There will a(n) (inverse/direct) relation between...”
 - e. Data: Table format
 - f. Results: Explain data
 - g. Conclusion: Explain the outcome of experiment. Do you support or refute your hypothesis? What can you do better for next time? Include limitations and variation that affected your data.
7. Extension: Students revisit model and design them to look like real plankton