GET TO KNOW A DRIFTER | EDUCATOR

Links to Next Generations Science Standards |
MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-PS2-4: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Links to Common Core Standards |
CCSS.ELA-LITERACY.WHST.9-12.2: Write informative/ explanatory texts, including the narration of scientific procedures/ experiments, or technical processes.

S T E M

Supplement Video |
https://www.youtube.com/watch?v=YnaGc9o3VXw
https://vimeo.com/163540126 (password: exploration)
Pacing | Several class periods
Background Needed | Basic understanding of current patterns and tracking methods
Assessment | Scientific Modeling & Communication Rubric provided
Materials/Resources |

- Various materials such as fabric sheets, scissors, styrofoam peanuts or other flotation material, toothpicks, wooden dowels, glue, putty, clay, legos, etc. for students to build their drifter models with
- Plastic bins filled with water for testing (*optional)
- Computers/internet access
- Online resources:
    - Engineering Design Process (http://nautl.us/2d7PDte)
    - 2015 HRP Presentation on Drifters Design Project (http://nautl.us/2dMvWJb)
    - http://studentdrifters.org
    - OET 2015 Drifter Deployments (http://nautl.us/2dMw3EB)
    - Oceanographic Standards for Drifter Design (http://nautl.us/2dJTWud)
    - High School Students Launch Research Drifters from Nautilus (http://nautl.us/2e81BiB)

Overview

This module provides students with the unique opportunity to learn about and explore the design process of an important oceanographic research tool: ocean drifters. Students will work in small groups to research structural and functional components of surface and deep water drifters, compare building materials and associated costs, and complete a design sketch. Students will create a model of their drifter and develop a hypothetical research proposal for how their drifter could be used to further scientific data collection.

Objectives & Learning Outcomes

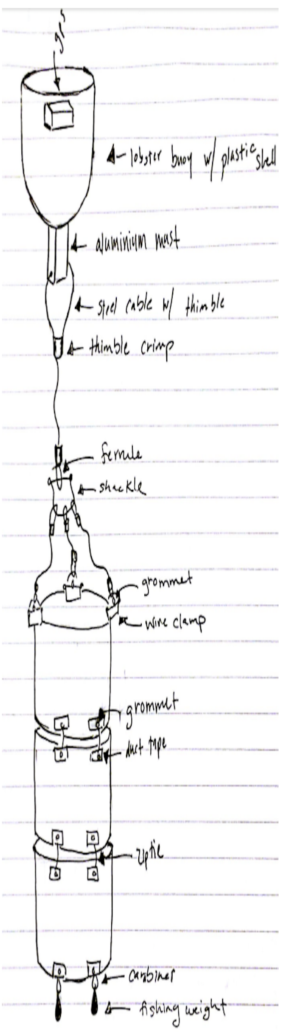
- Students will understand the importance of drifters in collecting scientific data.
- Students will understand the engineering design process by creating a building plan for either a surface or deep water drifter.
- Students will understand the difference in function between surface and deep water drifters.
- Students will summarize structural and functional components of drifters.
- Students will create a model with labels or key of their drifter.

Guiding Questions

- What are some differences in function between surface and deep water drifters?
- What effects do different design variables (e.g., surface area, mass, spar length) have on the function of your design?
- What are some benefits of using drifter data in scientific research?
- What are some of the tools required to construct a drifter?

GET TO KNOW A DRIFTER | EDUCATOR

The drogue drifter below is a student sample sketch from the 2015 Honors Research Program. Learn more about this program at http://www.nautiluslive.org/join-us.



Activity/Tasks

Students will:

- research oceanographic standards for drifter design (insert website here)
- research structure and function of various drifter components such as ballast, buoy, spar, drogue, sail, mast
- organize a method for keeping track of work flow, materials list, associated costs, etc.
- create a materials list with rationale for each component and associated costs
- discuss design and create labeled sketch
- build a model with labels or key of their design
- present a hypothetical research proposal to showcase design choices and use of drifter in a scientific study.

Educator: Lesson Procedure/Directions

✓ **LESSON SET-UP |** Teachers should implement their own grouping arrangement. Teachers can determine whether they will provide the model-building materials or have students bring in their own.

☐ Online resources:

- ☐ 2015 HRP Presentation on Drifters Design Project (http://nautl.us/2dMvWJb)
- ☐ OET 2015 Drifter Deployments (http://nautl.us/2dMw3EB)
- ☐ Oceanographic Standards for Drifter Design (http://nautl.us/2dJTWud)
- ☐ High School Students Launch Research Drifters from Nautilus (http://nautl.us/2e81BiB)
- ☐ http://studentdrifters.org

Guiding Research Questions

1. What are some differences in function between surface and deep water drifters?
   - ✓ **Possible answers:** Both are types of Lagrangian drifters, they enable us to observe ocean currents by tracking the motion of fluid parcels through space and time. Surface drifters are best used for tracking surface currents as determined by the wind, waves, and pressure forces; deep water for tracking sub-surface currents, which may be driven by density differences, internal waves, and pressure forces.
2. What effects do different variables (e.g., surface area, mass, spar length) have on your design?
   - ✓ **Possible answers:** weight being easily distributed to maintain an upright position, number and position of buoys for flotation and stability, weight of chain used for drogues affecting buoyancy, type of material used for spar, mast etc. affecting mass of components.

Extensions & Adaptations

Introductory | Simulate a real proposal to an evaluation committee by having students vote on which project should be funded. Discuss why the winning project was chosen.

Advanced | Students can use their research and itemized budget list to make a formal proposal requesting funding by a government or private agency to build their own drifter. They can contact organizations to seek assistance with deployment of their drifter. Students could test the buoyancy and stability of their models in a tank of water.

Guiding Research Questions Continued

3. What are some benefits of using drifter data in scientific research?
   - ✓ **Possible answers:** Ground-truthing current models, studying how currents vary in space and time, the study of coastal phenomena such as wind-driven upwelling and related biological events such as plankton booms.
4. What are some of the tools required to construct a drifter?
   - ✓ **Possible answers:** awl, screw drivers, drill bits, box cutter, drill, shackles, cutting shears, shackles, wire, grommet maker.

Define the following terms:

Students will be able to understand how the following elements can make their design more robust:

Ballast
- ✓ Material added to a design (rocks, lead weights, etc.) to provide stability while floating

Buoy
- ✓ Flotation device

Drogue
- ✓ A cylindrical anchor of four to seven sections, with a large hole through the center of each section; used on deep water drifters to provide drag.

Ferrule
- ✓ A ring or cap, usually metal, that strengthens the end of a handle, stick or tube and prevents it from splitting or wearing.

GPS Unit
- ✓ Global positioning system transmitter which signals to a global unit of satellites and back to a GPS receiver to determine location. Units are mounted in a water proof casing to the drifter.

Mast
- ✓ A type of spar; tall upright post generally carrying one or multiple sail(s).

Sail
- ✓ Fabric sheet to provide resistance; attached to the spars and mast; remains underwater to catch currents.

Spar
- ✓ A secondary support pole made of wood, metal or lightweight materials used to carry or support the sails.

Student Rationale & Analysis

- ✓ Students should be able to articulate their design process, describing why their model will be successful. Example: justifying mast or spar materials based on how molecular-level structure is important in the functioning of designed materials.
- ✓ Students should be encouraged to ask clarifying questions during their peers' presentations.

Student Procedure

1. Create groups and determine work flow plan.
2. Complete preliminary research/guiding questions and define all vocabulary terms.
3. Complete materials chart and design sketch.
4. Create a model of proposed drifter.
5. Complete a hypothetical research proposal for the use of designed drifter.
6. Present model and research proposal to class.

Assessment Tip

- ✓ Both the "Presentation Rubric" and "Scientific Modeling & Communication Rubric" have been included for grading purposes. You may choose to use one or both rubrics for different aspects of this module. Students may also complete a peer or self assessment using either of these rubrics.

GET TO KNOW A DRIFTER | STUDENT

Challenge: Design and construct a model surface or deep water drifter to match the scientific objectives of a study you design.

Learning Goals

- Understand the drifter engineering design process.
- Understand the difference in function between surface and deep water drifters.
- Summarize structural and functional components of Lagrangian drifters.
- Understand the importance of drifters in collecting scientific data.
- Work as a team to prepare a design plan, build a model and come up with a research proposal rationalizing the use of your drifter for scientific data collection.

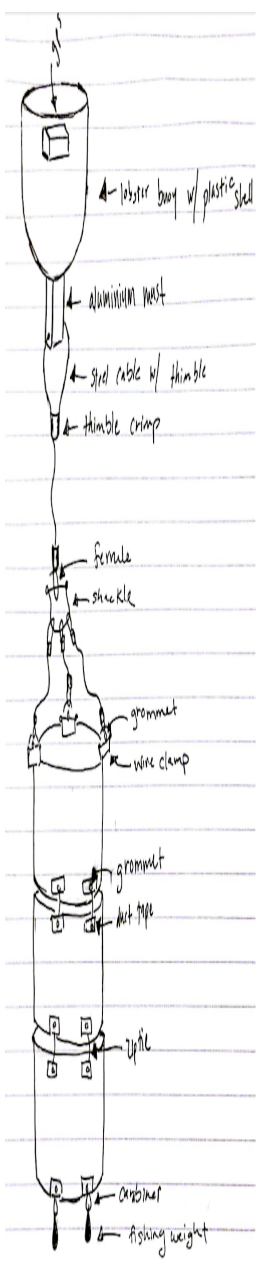
Introduction | Have you ever heard of an oceanographic drifter? Drifters are instruments that move according to factors driven by ocean forces. Drifter data is used all over the world to help scientists track weather events, current systems and biological events such as algal blooms. There are two types of tools that collect a variety of fluid dynamic and oceanographic data: Eulerian and Lagrangian. The Eulerian type track fluid motion in a specific location, such as anchored buoys or a fixed weather station. Lagrangian drifters track fluid motion through space and time either at the surface (surface drifter) or sub-surface (deep water drifter or drogue). These drifters move with associated currents and are able to transmit data to satellites from their attached GPS units. Surface drifters remain in the top one meter of the water column while drogues are suspended to a certain depth below the water's surface. Learn more about drifters from Captain Emil Petruncio, United States Naval Academy Oceanography Department Chair, here (http://nautl.us/2dozcUZ).

This summer eight high school students designed and deployed drifters from *Nautilus*. Read *High School Students Launch Research Drifters from Nautilus* here (http://nautl.us/2e81BiB). In this module, you will learn the basics of Lagrangian drifter design and function. You will build a model of either a surface or deep water drifter and create a research proposal using your drifter to collect data on a scientific question. You will present your drifter design model and proposal to the class.

On the working, back deck of *Nautilus*, students from the 2015 Honors Research Program prepare to deploy a surface drifter off the California Coast.

GET TO KNOW A DRIFTER | STUDENT

The drogue drifter sketch below was a student draft design from the 2015 Honors Research Program.



Procedure |

1. Complete guiding questions and vocabulary terms.
2. Consult with group members and choose to design either a surface or deep water drifter. See resources at left for reference.
3. Research design methods and materials.
4. Complete materials chart noting rationale(s) and costs (worksheet 1).
5. Draw a design sketch of your drifter labeling all components (worksheet 2).
6. Decide the materials needed to build a model of your drifter and construct.
7. Create a research proposal on how your drifter could be used to further science and present to the class.

Guiding Questions |

Answer the following questions with your group members to get more acquainted with drifters:

1. What are some differences in function between surface and deep water drifters?
2. Provide at least 2-3 examples of how different variables (e.g., surface area, mass, spar length, weight of chain) can affect drifter design and performance.
3. What are some benefits in using drifter data in scientific research?
4. List and describe some of the required tools needed to assemble a drifter.

Work as a Team

When people of multiple backgrounds and abilities come together to solve a problem it is crucial they have a clear communication and work flow plan. When working on this challenge think about how to best manage the group responsibilities to accomplish this task on time. It may be helpful to brainstorm organizational strategies that will help your team efficiently manage information and collaborate equally on the final product.

Drifter Resources Online

NOAA Drifters http://studentdrifters.org

Oceanographic Standards for Drifter Design

BBC Lego Ocean Currents http://www.bbc.com/future/story/20140722-odd-objects-reveal-ocean-secrets

Drifters in Oil Research http://carthe.org/

Pollutant Transport on Currents http://gulfresearchinitiative.org/study-shows-drifter-data-surface-currents-critical-predict-pollutant-transport/

Vocabulary |

Ballast:

Buoy:

Drogue:

Ferrule:

GPS:

Mast:

Sail:

Spar:

Worksheet One

Materials Chart | Complete this chart to organize your list of materials, their function in the design, and estimated cost of building the drifter you designed. The final cost should be incorporated into your research proposal.

Material Description	Purpose in Design	Quantity	Cost per Unit (CPU)	Total Material Cost (quantity x CPU)
			PROJECT TOTAL COST:	____________

Worksheet Two

Design Sketch | Use this worksheet to sketch the final rendition of your drifter. Make sure to label all components. You may also want to note in your labels which materials will be used for your model. Your teacher will give you further instructions on how to obtain model materials.

Worksheet Three

Research Proposal | Use the following points to help you draft your research proposal. Your instructor will provide further details on the presentation protocol and schedule.

- Research Topic/Why Important:

- Hypothesis:

- Details of proposal:
    - Planned launch site:
    - Ideal length of study:
    - Instruments onboard/ Types of data collected:
    - Cost of drifter:

- Conclusion: Reiterate the benefits of the study; what can be gained by investigating, why your design is cost-effective, and how your design was customized for this research.

GET TO KNOW A DRIFTER | ASSESSMENT

Presentation Rubric

OBJECTIVE	CRITERIA			
	4 Exemplary	3 Commended	2 Emerging	1 Developing
Organization |	Student presents information in a logical, interesting sequence which audience can follow. Student capitalizes on audience interest and background knowledge to enhance understanding.	Student presents information in a logical sequence which audience can follow. Student utilizes some audience interest and background knowledge to enhance understanding.	Student inconsistently presents information in a logical sequence which audience can follow. Student attempts to utilize audience interest and background knowledge to enhance understanding.	Student has difficulty presenting information in a logical sequence which audience can follow. Does not utilize audience interest and background knowledge to enhance understanding.
Content Knowledge |	Student does not rely on notes or memory aids; demonstrates full knowledge by answering questions with extended explanations and details.	Use of notes or memory aids is minimal; demonstrates knowledge by answering all questions; may fail to elaborate.	Student frequently relies on notes or memory aids; able to answer rudimentary questions.	Student does not have grasp of information; notes or memory aids may be heavily relied upon; student is unable to answer questions.
Delivery and Audience Engagement |	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear. Maintains eye contact with audience. Relaxed and polished delivery style enhances presentation.	Student uses a clear voice and correct, precise pronunciation of most terms. Maintains eye contact with audience most of the time. Confident delivery style.	Student inconsistently uses a clear voice and correct, precise pronunciation of terms. Occasionally maintains eye contact with audience. Student has difficulty presenting confidently.	Student does not use a clear voice. Correct, precise pronunciation of terms is weak. Minimally maintains eye contact with audience. Student has difficulty presenting confidently.
Graphics, Visual Aids, and/or Products |	Resources carefully prepared to enhance presentation; easy for audience to read and/ or view; demonstrates creativity; contains no grammar or spelling errors.	Uses resources to relate to presentation; easy for audience to read and/or view; some creativity exhibited; may contain minor grammar or spelling errors.	Occasional use of resources which enhance presentation; may be distracting to audience or may be difficult to read or view; little creativity exhibited; contains grammar or spelling errors.	Minimal use of resources to enhance presentation; may be distracting to audience or may be difficult to read or view; Little to no creativity exhibited; Contains grammar or spelling errors.
Total Score: __________	**Comments:**			

Scientific Modeling & Communication Rubric

OBJECTIVE	CRITERIA			
	4 Exemplary	3 Commended	2 Emerging	1 Developing
Evidence of Planning and Research |	Student submits thoroughly completed and accurate worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic.	Student submits completed and mostly accurate worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic.	Student submits partially completed worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic. Some information may be inaccurate.	Student submits minimally completed worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic. Information may be inaccurate.
Student Model or Product |	Adheres to all guidelines and expectations set forth. Model or product exhibits neatness, creativity and thoughtfulness in design.	Adheres to most guidelines and expectations set forth. Model or product exhibits neatness, some creativity and thoughtfulness in design.	Adheres to some guidelines and expectations set forth. Model or product exhibits some neatness, creativity and thoughtfulness in design, or these may be inconsistent.	Adheres to few guidelines and expectations set forth. Model or product does not exhibit neatness, creativity or thoughtfulness in design.
Communication of Content |	Student is able to thoroughly discuss content through use of their model/ product. Student thoroughly completes all associated follow-up worksheets, questions, reports, etc. with no content errors. Student can answer questions about their ideas using examples from what they learned.	Student is able to discuss content through use of their model/product. Student completes follow-up worksheets, questions, reports, etc. with few content errors. Student can answer questions about their ideas using examples from what they learned.	Student is able to weakly discuss content through use of their model/ product. Student completes some associated follow-up worksheets, questions, reports, etc. There may be some content errors. Student can answer rudimentary questions about their ideas.	Student is able to minimally discuss content through use of their model/ product. Student minimally completes associated follow-up worksheets, questions, reports, etc. Student has difficulty answering questions about their ideas.
Total Score: ____________	**Comments:**			

How Large is Nautilus Nation?

Tracking the reach of Ocean Exploration Trust's education programs is essential in ensuring we are funded to continue making discoveries and inspiring the next generation of explorers.

Name:

My Community (City, State):

Email Address:

School's Name:

Instruction date:

Grade level instructed:

Subject area:

My education space is a...
❏ Classroom ❏ After school program / Club meeting ❏ Fair / Festival / Event ❏ Museum / Science Center ❏ Other. Tell us more:

Who did you engage in your teaching?
Students
Community Members

Select all the OET materials you used in your instruction:

- ❏ STEM Learning Modules. Which ones? ______________________________
- ❏ Digital Resource Library materials. Which ones? ______________________________
- ❏ Nautilus Live website: photo albums ☐ highlight videos ☐ live stream
- ❏ Meet the Team STEM mentor profiles
- ❏ Facebook (NautilusLive) ☐ Twitter (@EVNautilus) ☐ Instagram (@nautiluslive)
- ❏ Other. Tell us more: ______________________________

____

What made working with OET resources valuable to your instruction (select all that apply)?

- ❏ Hands-on activities
- ❏ Easy to use lessons
- ❏ Website resource access
- ☐ STEM career connections
- ☐ Standards-based lessons
- ☐ Real world application of curricula topics
- ❏ Excitement of cutting-edge discoveries / Unfamiliarity of deep ocean
- ❏ Another reason. Tell us more: ______________________________

____

Using OET resources increased my confidence in teaching my science, technology, engineering, or math subjects.	☐ Yes	☐ No
OET provided me with helpful and relevant teaching resources.	☐ Yes	☐ No
Using OET resources increased my awareness of STEM careers.	☐ Yes	☐ No
If yes, how so? How can we improve?		

Please scan this document or snap a picture of it with your phone. Email the feedback or questions to education@oet.org. You can also submit feedback online: http://nautl.us/2cp3PNu

Thank You For All You Do!