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The Secret Life of Diatoms: An Exploration of the Fascinating World of Diatoms through the Art of Printmaking

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The secret life of diatoms: An exploration of the fascinating world of diatoms through the art of printmaking

Age Range: 14 through 100+

Time: 2 hours – 30 minute lesson, 1.5 hours for printmaking

Curriculum designed by Zofia Danielson with advising from Dr. Brady Olson for Western Washington University Honors College Capstone

Program developed Spring Quarter 2022

Virtual Kit Includes:	**Material List Includes:**

• Lesson plan
• Instructions
• Materials
  - Introductory PowerPoint
  - Diatom posters
  - Instructions for linocut printmaking
	• Introductory PowerPoint
	  - Copies of introductory PowerPoint for notetaking
	• Diatom posters
	• Pencils – 1 per workshop attendee
	• 3x5” linocut relief print rubber stamps – 1 per workshop attendee
	• Linocut carving tools (with blades) – 1 per workshop attendee
	• 4x6” printmaking paper (40 sheets or more)
	• 1 large sheet of printmaking paper (for diatom bloom)
	• 2 tubs of water for cleaning printing blocks
	• Paper towels
	• Paper or plastic sheet to cover tables with

	• 3 or more plastic printing pads for ink • 3 brayers • Water-based relief printing ink - Suggested colors: black, green, blue, turquoise, brown

Lesson Objectives:

1. Teach audience what diatoms are/why they are important
2. Look at local species of diatoms and observe adaptations they have made to thrive in their marine environments (spines, size, chains, etc.)
3. Learn to create relief prints of diatoms
4. Create a "plankton bloom" by the end of the workshop with prints from each workshop attendee

Final Outcomes:

1. Gain an understanding of why diatoms are important to nearshore coastal ecosystems.
2. Use close observation and scientific inquiry to gain an understanding of why diatoms have developed different forms to serve different functional purposes (anti-predation, ability to float, competitive advantages, etc.).
3. Create prints based on the diatoms observed in the workshop that tie in aspects of function and form learned in the workshop through observation and inquiry.

Instructor Preparation:

- Read lesson plan
- Familiarize yourself with diatoms, primary production, nutrient cycling related to diatoms (oxygen, biological pump, photosynthesis and energy transfer through food web)
- Gather materials to make a sample
- Set up tables with a pencil, rubber stamp block, and carving tool for each participant

- Set up inking station with one color of ink spread with a brayer on each plastic printing pad, paper towels, printmaking paper, and nearby tubs of water
- Set up a table for drying prints on

Diatom Lesson Outline:

1. What are diatoms?
    a. Talk about the root of the word and how it is related to the frustules (two halves of glass)
    b. There are 100000-200000+ species estimated worldwide.
    c. Diatoms are a type of primary producer that fall within the group of phytoplankton
        i. Their golden-brown color comes from accessory pigments
        ii. This contrasts from chlorophytes which only have green pigmentation.
    d. They are microscopic organisms.
        i. 2-200µm in size
            1. Approximately 10 can fit on the head of a pin.
    e. Diatoms are eaten by zooplankton which, in turn, are eaten by other, larger organisms, similar to plants on land.
    f. They build ”glass houses” made of silica.
    g. They are single-celled organisms (unicellular).
        i. They may form chains
2. Diatoms play many important roles in ecosystems in the water and on land.
    a. They contribute to productive coastal ecosystems, are large contributors to global oxygen production, and play important roles in marine nutrient cycling.
    b. Productive Coastal Ecosystems
        i. Diatoms, which are primary producers, harness the energy of the sun to photosynthesize.
        ii. This creates energy in the form of sugars which other, larger organisms need to survive.
        iii. Productive marine food webs rely on abundant diatom populations.
    c. Productive Coastal Ecosystems continued

i. Diatoms and other species of phytoplankton form the base of marine food webs. They produce sugars which are used as energy for other, larger organisms in the ocean, all the way up to salmon, seals, and orcas.

d. Diatoms contribute to global oxygen production.
    i. The chemical equation for photosynthesis represents the chemical process diatoms undertake as they produce oxygen and sugars out of carbon dioxide and water through the uptake of light energy from the sun.
    ii. Plankton produce ~50% of the world's oxygen daily.
    iii. 45% of global primary production and yet represent only 1% of Earth's photosynthetic biomass.
e. Diatoms are key players in many important nutrient cycles.
    i. Diatom blooms can occur in nutrient-rich water
    ii. These blooms occur seasonally after winter periods of dormancy.
    iii. Diatoms are a major "sink" for carbon dioxide globally.
        1. As they die, their "glass house" bodies which hold carbon sink into sediments at the bottom of the ocean.
    iv. Diatoms build "glass houses" made of silica.
        1. They can be used to measure changes in climate based on the preserved carbon in their silica-based shells that has been incorporated into sediments.
        2. Temperature affects the way that diatoms build their glass houses.
f. Plankton are key players in global carbon sequestration at the bottom of the ocean.
    i. As they die, they sink to the bottom and are buried in sediments and produce nutrients
        1. These nutrients can be taken up by deepwater circulation and distributed throughout the global ocean.
g. How do they build their "glass houses?"
    i. The shells, or "frustules" are built from dissolved silica in water (bio-engineer their glass houses)
    ii. Pros of building glass houses include:
        1. Strong shell
        2. Anti-predation

3. High abundance in environment
4. Fairly insoluble

iii. Cons of building glass houses:
1. Impermeable (but not with adaptations!)
2. Cannot grow as cell grows

h. Diatoms come in many different forms which allow them to adapt to life in the ocean. There are tradeoffs to these differences in forms.
i. Centric/Pennate
1. Talk about the differences in symmetry between centric and pennate diatoms (radial versus bilateral)
2. Point out different parts of centric diatoms (frustule, girdle, hypotheca, epitheca)
3. Point out different parts of pennate diatoms (raphe, stigma, striae)
4. Talk about the pores which make diatoms permeable to nutrient uptake and the beauty in the patterns of the pores.

ii. Chains
1. Some diatoms create chains out of thin glass linkage points.
a. Pros to building chains:
i. Increased surface area
ii. Anti-predation
iii. Resistant to turbulence
iv. Decrease sinking rates
b. Cons to building chains:
i. Fragile
ii. Anti-predation

iii. Spines
1. Some diatoms grow spines made of glass.
a. Pros to building spines:
i. Sink slowly
ii. Deters predators
iii.
b. Cons to building spines:
i. Fragile
ii. Energetic cost

iv. Size
    1. Diatoms are different sizes which have tradeoffs.
        a. Small diatoms:
            i. Sink slowly
            ii. Available to more predators
            iii. Larger surface area-volume ratio
                1. Can survive in low nutrient environments
        b. Large diatoms:
            i. Sink quickly
            ii. Deters predators
            iii. Lower surface area-volume ratio
                1. Need a lot of nutrients

Printmaking Lesson Outline:

1. Art and science have worked in conjunction for hundreds of years.
    a. Why use art to communicate science?
        i. A different way to communicate science
        ii. Break down barriers
        iii. Disarming way to communicate
        iv. Bridges skills used across disciplines
            1. Close observation, critical thinking, etc.
2. Ernst Haeckel created detailed scientific illustrations of organisms in the 1800s.
    a. Lived from February 16, 1834 – 1919
    b. German scientist that focused on evolutionary history/ phylogeny
    c. Interested in symmetry
    d. Created detailed scientific illustrations of organisms during a time when microscopes were expensive and not accessible to the general public.
        i. These illustrations made science and organisms such as diatoms, which are too small to see with eyes, accessible to more people.
    e. Show some examples of his work.

3. Go over entire process for sketching and printmaking before participants begin to sketch.
    a. Sketching diatoms—participants begin to sketch diatoms to use for their relief prints.
        i. The example diatoms posters included in this virtual kit may be used.
        ii. Questions to guide sketching:
            1. What shapes are you noticing?
            2. Are the diatoms symmetrical?
            3. What kinds of symmetry do you observe? Radial, bilateral, etc.
            4. What features do you notice that might help these diatoms adapt to life in the ocean? Spines, size, etc.
            5. Are there any details that you want to include in your sketch?
    b. Printmaking:
        i. Talk about the importance of negative space as participants begin to transfer sketches to rubber blocks for carving.
            1. Negative space: the space around an image.
                a. The goal is to not get ink in the negative space of your design
                b. What you carve away will be white space in your stamp block
                c. What is left is the “positive space”
                d. It will be covered in ink
            2. Show an example of your stamp to illustrate this.
            3. Participants can make several prints for themselves.
            4. Ask them to add a print to the large piece of printmaking paper to create a “diatom bloom” with all participants’ art.
        ii. Instructions for linocutting:
            1. Transfer your sketch to your rubber block by flipping sketch onto block and shading over the sketch with your pencil
            2. Color in the parts of your sketch that you want to be dark vs. light

3. Use a smaller blade to carve out details and a larger blade to carve out larger spaces
4. Take your block to the ink station and ink up!
5. Place your block on a piece of printing paper and lightly press it down
6. Flip your block over and use the pressing tool to press on the back of your paper in a circular motion
7. Gently lift your paper off of the stamp
8. Write your name on your print and place it at the drying station

Closing Outcomes:

- Participants will gain a better understanding of what diatoms are, what roles they play in marine ecosystems, and the beautiful adaptations they have made to their form.
- Participants will be able to create a linocut print.
- Participants will have several prints to take home.
- Participants wil l add to the workshop “diatom bloom” for installation in Shannon Point Marine Station.

Workshop Reflection – May 27th, 2022

Overall, this workshop, conducted in May 2022 at the Shannon Point Marine Center, was a success. Ten participants from Anacortes and Bellingham, Washington attended the trial run of this workshop. All 10 participants enjoyed the workshop, and the most common workshop outcomes reflected on in the exit survey were that the diatom bloom was a good end product of the experience, and participants had a better understanding of what diatoms are and what they do in marine ecosystems, with most participants recalling their importance to global nutrient cycling and global oxygen production. Additionally, participants found the "glass houses" diatoms build particularly intriguing, especially in regard to the many forms these glass houses take. Other comments were that "diatoms are beautiful" and that the linocut relief printmaking process was not as difficult as participants expected.

For the next iteration of this workshop, there are several modifications to make. Some participants stated that they wanted more time to make additional prints. Printing out the introductory diatom presentation slides for notetaking may allow participants to recall more information about diatoms and will provide more images of diatoms to look at. Additionally, taking more time to explain linocut printmaking and the connection between sketching the diatoms and

making prints out of them will streamline the instructional segment of this workshop. Explaining concepts such as the biological pump with simplified vocabulary will help workshop participants who do not have science backgrounds understand the terminology included in this workshop. Personally, I began the introductory presentation by speaking too quickly, so I will work on slowing down my presentation before the next time this workshop is put on.

There are many opportunities to create extensions for this workshop. Including a segment for a plankton tow and microscope work will allow participants to gain hands-on experience identifying local diatom species and creating prints from them. This extension also provides a foundation to putting on seasonal iterations of this workshops, where participants can gain insight into seasonal differences in diatom species. This workshop may also be edited for different age groups so that the linocutting portion is more accessible to a younger audience. Additionally, this workshop may be adapted for other fields of science or ecological concepts which would open more avenues for cross-disciplinary collaboration.