LESSON PLAN 6:

BIOMIMICRY

DESIGN CHALLENGE

Curriculum: Introduction to Biodesign
Unit: 2––Biomimicry
Grade Level: 10th-11th

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Nature Lab 1

Overview of this lesson:

Lesson 6, the Biomimicry Design Challenge, gives students an opportunity to apply their understanding of biomimicry to a real-world problem. It is the culminating lesson of the unit, in which we review biomimicry as a design tool and the way in which nature "designs" through adaptation and natural selection. Armed with these ideas and strategies, we set students off to make their designs. The challenge is to choose an organism (or continue with the organism they chose in Lesson 5), and apply one of its features to solve a human problem. These designs can solve small or big problems: some students might envision ways to provide shelter in natural disasters, while others may come up with the perfect lunchbox. Both are perfectly fine.

It is important to note that while we present this as a single lesson plan, in reality we stretched this "design challenge" class over two sessions—giving students a total of about four hours of class time to work on their designs. We found that while our students were enthusiastic about their ideas and the initial material exploration, it was often difficult for them to reconcile the complex ideas they had imagined with what could be feasibly built in the classroom given their ability level, time, and material constraints. In order to give students enough time and support to actualize sometimes-ambitious designs, we extended this lesson into the following class.

Adapting this lesson to your classroom:

To help facilitate individual progress, our group of four co-teachers put together packets with more information about the organism that students had chosen, references to other designs or designers that worked with similar ideas, and instructions for certain making techniques (how to make an orb out of paper, for example). Packets with supplemental information can certainly help students along when they hit snags in their design process, but are not necessary. Encourage students to make multiple iterations, rather than be wedded to one model that is giving them trouble. It is also helpful to free students from the expectation that they will produce a highly polished, professional looking design in a matter of hours. While the making component of this lesson is not to be discounted, the purpose of this lesson is for students to apply what they've learned about Nature's design approaches to a problem in the human world, and to understand the value of iteration.

A note on timing: With our group of students, we used an hour in one class and an hour in the next class, which we felt was appropriate for students to adequately develop their designs. How much time you allot is, of course, proportional to how "finished" you want these designs

to be; if you want students to get out of the conceptual phase and make more refined looking designs, this is two or three class project. If you're comfortable with rough designs that are more about the conceptual than the technical, this can happen in one class. This lesson can further be extended if your incorporate the biomaterials, and have students make pieces for their prototypes from biomaterials explored in the first unit.

Grade Level: 10th-11th

Duration: 2-4 hours (can be extended into the next class)

Lesson Concept: Understanding how Nature refines design over time can give us insight to iterative design.

Lesson Objectives/Learner Outcomes:

1. Apply principles and properties borrowed from nature's design to human design.

2. Understand the purposes and applications of critique in art and design and practice critiquing one's own and others' work.

Instructional Support Materials (if needed):

• Powerpoint with necessary images + journal prompts.
• LCD projector/smartboard
• "Design Considerations" Worksheet

Materials + Supplies:

• Printer paper or newsprint for models (enough for each student to have a small stack of paper)
• Scissors (for each student)
• Tape (a roll for every small group, or, ideally, per student)
• Glue (a glue stick for each student or hot glue guns to share)
• String or yarn (several yard-lengths per small group)

Science / Art

Standards

SCIENCE (Next Generation Science Standards):

LS4B Natural Selection - Natural Selection occurs only if there is variation in the genes and traits between organisms in a population. Traits that positively affect survival can become more common in a population.

LS4C Adaptation - Evolution results primarily from genetic variation of individuals in a species, competition for resources and proliferation of organisms better able to survive and reproduce. Adaptation means that the distribution of traits in a population, as well as species expansion, emergence or extinction, can change when conditions change.

ART (National Core Art Standards):

VA:Cr3.1.iia Engage in constructive critique with peers, then reflect on, re-engage, revise, and refine works of art.

Learning Plan

Stage 1: Motivation

1. Introduction Lecture Part I: Review evolution, iteration, and biomimicry. Review material covered in the last two classes, evolution, iteration, and biomimicry. Show powerpoint if needed. *(10 minutes)*

2. Introduction Lecture Part II: Introduce Biomimicry Design Challenge. Review with students, "Over the past two weeks, we've been looking at how we might gain insight into designing for the human world by studying how nature resolves design challenges and 'iterates designs.' We've looked at this through the lens of adaptation and natural selection, wherein we can see how organisms respond to external forces, and then through biomimicry, wherein designers borrow from specific adaptations and mechanisms in the natural world to make human designs better. For this class (and next, if you can give over more class time to this project) we are undertaking the Biomimicry Design Challenge. Our question is: how might we borrow from nature's design to create a human application for our 'works like' models?" (for more information on "works like" models see Lesson 5). Provide students with an example of what this might look like, such as, "Perhaps you spent the last class looking at the way a crab is able to move its claw in multiple ways to pick up and drop things, and you think that this same mechanism might work well for a robotic arm. Maybe you've been looking at a hermit crab's shell and you have an idea for a design for a similar, portable shelter for humans in need of safe, temporary housing. Choose a feature (or several) of the organism you chose last class, and apply this in some way to solve a human problem, big or small. Your designs can address problems as big as homelessness or climate change, or as small as making a slippery or icy sidewalk a little more safe to walk on. You can use paper, glue, cardboard, cloth, colored pencils, glue, or any other materials that are in the classroom that can be used safely and with minimal set-up/clean-up." *(10 minutes)*

Provide students with "Design Considerations" worksheet (see end of PDF) that helps them to consider what their designs will need and look like. Give students five-ten minutes to use this worksheet to brainstorm ideas. *(5-10 minutes)*

Image: RISD industrial design students' biomimicry models, inspired how organisms "work."

Stage 2: Exploration

1. Studio Time for Creating Biomimicry Designs. Students will have the remaining class time to plan for, actualize, and revise their biomimicry designs. Teachers/table leads will help students as needed in working through designs. *(60 minutes)*

Stage 3: Reflection

1. Critique: Students clean up and return to tables/small groups to practice critiquing one another's designs. We talked with our students about the meaning of critique, the role it plays in artists' processes and in improving work outcomes. Because many of our students were unfamiliar with critique, to make this process more approachable we broke students into small groups and provided "Critique Prompt" cards to each student. Each student presented her design to the small group, spoke about what organism she drew inspiration from and how she made it, and then students in the group randomly drew cards with prompts for critique. These said: "Say one thing you think was successful about the design"; "Say one thing you think could be improved upon in the design"; "Suggest a title or a name for the design"; and "Suggest an alternative use for the design." Students then pass their cards to the left, and a new student presents her work. We felt this gave each student an active role **in** the critique process and that these assigned roles helped students be honest with and helpful to each other. If you have more than five students in a small group, feel free to add other prompts like: "Ask a question of the artist" or "Suggest a resource, designer, or artist for the designer to look at for further inspiration." *(25 minutes)*

2. Five-Minute Journaling. Students clean up and return to tables to journal for five minutes. Teacher can pick one prompt for all students to respond to, or students can choose from three prompts. *(Writing: 5 minutes, if desired: 5 minute pair share or group share)*

- In what ways did your model change? What problems did you encounter? How did you resolve them, if at all? Write a paragraph or make a drawing.
- Imagine you had to explain what biomimicry is to a friend or to someone at home. How would you teach the idea of "biomimicry"? Write down what you might say and what you might have your "stu-

Image: One student's design (and paper iterations) for an umbrella/form of shelter, inspired by a jellyfish.

dents" do or look at to understand what biomimicry means.
· If you had unlimited time and an unlimited budget, what nature-inspired design would you like to create? Draw it or describe it.

3. "So what?" Lesson Recap. Ask students: What did we do today? Why is it important? Emphasize key ideas covered and larger context for today's learning—for example "In this unit, we've been studying how organisms in nature, and design objects both evolve over time in response to external forces in a changing environment. Biomimicry allows us to adapt design strategies from the natural world to solve design problems in the built environment. This can be useful as we continue to **think** about how to live and design in ways that benefit our environment, rather than damage it." *(5 minutes)*

Image: A student cuts boxboard for his design while a teacher looks on.
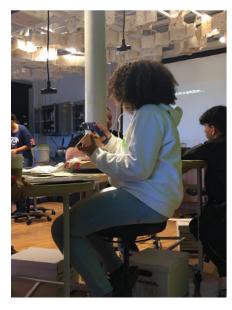
Image: A student working on her design during studio time.

Design Considerations Worksheet

As you work on your design consider the following questions and write down a sentence or two in response to each. Be ready to address these questions during critique.

1. Who is going to use your design?

2. How long does it need to last?

3. What materials could it be made of and what effect will this have, long term and short term, on the environment?

4. Does it have more than one function? Should it? Consider that the organism on which your design is based does not have just this one "function".

5. How much does it cost?

6. Is there a demand for it? If so, what is the demand?

7. What other forms could this design take?

Prompts For Critique

Say something that you think is successful about the design

Say something that you think could be added or improved upon in the design

Suggest an alternate use for the design or a different form the design could take

Suggest a title or name for the design

Vocabulary

Terms:

Critique: The process of evaluating and giving feedback about others' ideas and artworks. Can be a verb ("we are going to critique now") or a noun ("we are having a critique today in class.")

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