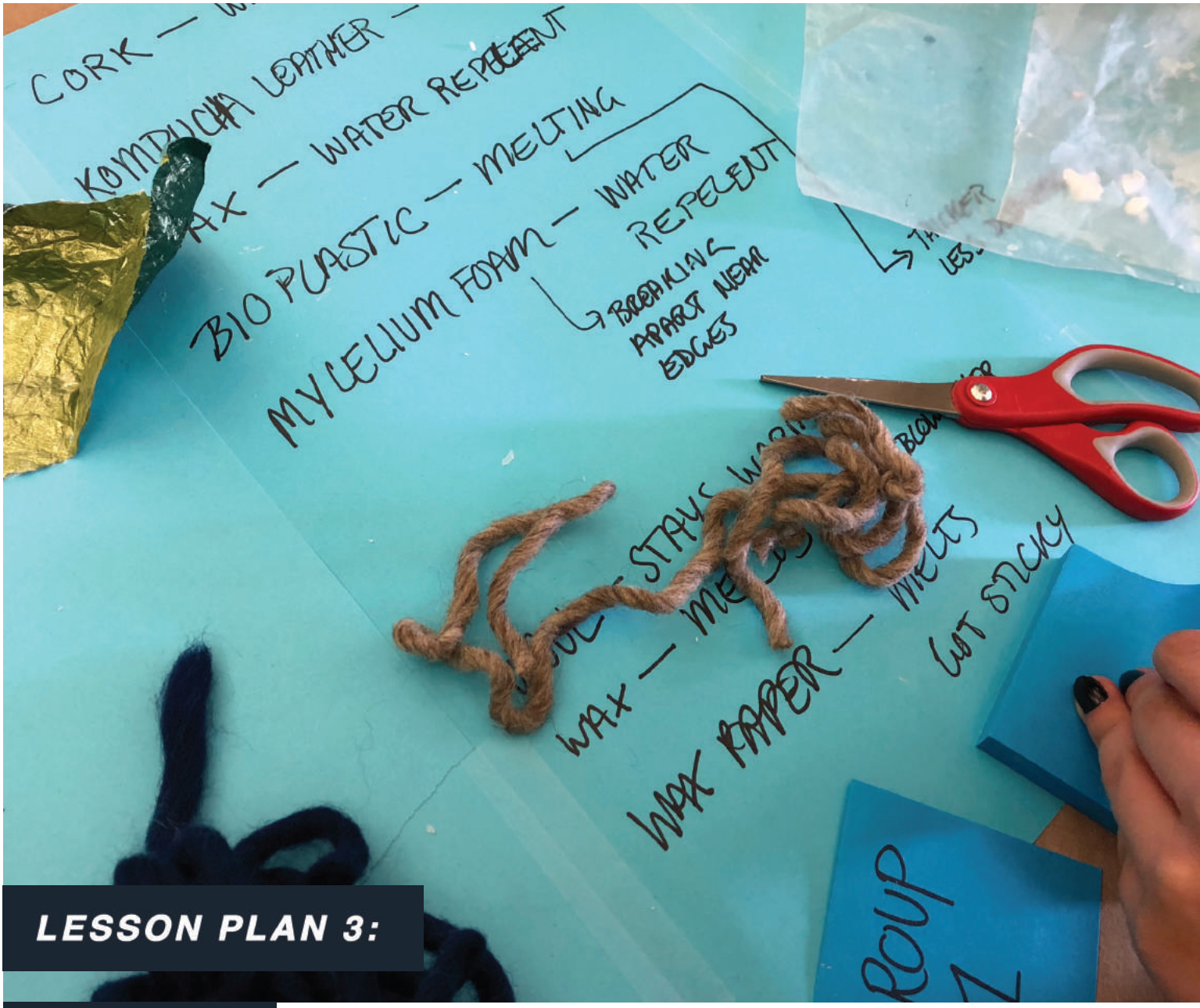

LESSON PLAN 3:

COMPOST

& DECOMPOSITION

Curriculum: Introduction to Biodesign
Unit: 1—Biomaterials
Grade Level: 10th-11th

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TO FIND MORE LESSON PLANS AND TO READ MORE ABOUT THIS CURRICULUM VISIT: BIODESIGNMAKERSPACE.ORG

Background Information For Teachers

Overview of this lesson:

In Lesson 2, we led our students in the making of three types of biomaterials: bioplastic, kombucha leather, and mycelium. In this lesson, Lesson 3, we used those same materials to frame our learning about materi al "waste" in nature and the built environment.

We began by illustrating for our students how the natural world does "packaging" by handing out clementines and bananas to eat during our introductory lecture. A banana comes with its own packaging that lasts exactly as long as it needs to without leaving behind material waste for centuries after its useful life (unlike synthetic plastic, for example). This is an easy way to make clear to students the many design challenges that the natural world has already found solutions for, that benefit the natural world rather than damage it. At this point in our lesson, we showed our students a six minute National Geographic video "A brief history of how plastic changed our world", available online for free viewing.

After viewing and discussing the video, we previewed the day's activity for the students. In this lesson, we explore and record the properties of a number of materials (including the three biomaterials we made last class) and place them in a composting chamber to observe how they biodegrade over time. While some students seemed to be familiar with the basic premise of composting, we took a few minutes to explain the meaning and mechanisms of biodegradation.

Adapting this lesson to your classroom:

Key to the success of this lesson is having clear composting chambers and worms to aid in the decomposition. We were lucky to have several small glass aquarium tanks at our disposal (which is ideal), but you can achieve a similar effect by using plastic storage bins or, in a pinch, two-liter soda bottles with the tops cut off. We broke our students into groups of four or five, each group with their own composting chamber, because we felt that it was important for students to be involved in handling the materials rather than watching from afar. Small groups permit students a more active exploration of materials properties, so if at all possible, keep group size to five students or smaller. Also note: if students don't want to keep their kombucha leather, bioplastic or mycelium made in the previous class, the composting chambers are a great place for these samples to go.

Standards, Objectives, & Supplies

Grade Level: 10th-11th

Duration: 2 hours

Lesson Concept: There is no material waste in nature – everything is used, repaired and/or becomes food for something else. A thing only lasts as long as it needs to last. What if we designed in the built environment with this strategy?

Lesson Objectives/Learner Outcomes:

1. Understand that traditional and non-traditional materials may impact human health and the environment.

2. Understand, through hands-on exploration, that there is no material waste in nature and that different materials have different lifespans.

Instructional Support Materials (if needed):

- Powerpoint with necessary images + journal prompts.
- LCD projector/smartboard
- Vocab cards for each student to paste in journal (see end of PDF)
- "Material Exploration" Worksheet for recording observations (see end of PDF)

Materials + Supplies:

Fruit

- bananas (enough for each student to have one)
- clementines (enough for each student to have one)

For Exploring Materials' Properties:

- Hairdryer (one per small group of 3-5 students)
- Beakers of water (one per small group of 3-5 students)
- Water droppers (one per small group of 3-5 students)
- Scissors (one per small group of 3-5 students)

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Science / Art Standards

SCIENCE (Next Generation Science Standards):

LS2B Cycles of Matter and Energy Transfer in Ecosystems - The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.

ESS3A: Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits

ART (National Core Art Standards):

VA:Cr2.2.ia: Explain how traditional and non-traditional materials may impact human health and the environment and demonstrate safe handling of materials, tools, and equipment.

Standards, Objectives, & Supplies

(Continued from previous page)

Materials for Composting Chambers:

- Bioplastic samples (a 2” x 2” square or around this size, one per small group of 3-5 students)
- Mycelium samples (around 2” x 2” square or one per small group)
- Kombucha leather samples (around 2” x 2”, one per small group)
- Conventional plastic (one per small group)
- Yarn or wool (a length of 6” to 12” per group)
- Banana and orange peel or other food waste (one per small group)

Composting Chambers

- Glass Chambers (small aquaria) for vermicomposting (one per small group of 3-5 students)
- Soil (enough to pack at least 4” of soil in chamber)
- Worms (5-10 per each composting chamber)
- Labels for labeling each composter (one per small group)

Learning Plan

Stage 1: Motivation

1. Introduction Lecture Part I: How does Nature create "packaging"? How do humans create packaging? While students settle in, distribute bananas and clementines for students to eat, encouraging students to consider how a banana or a clementine comes with its own packaging (the peel) that lasts exactly as long as it needs to without leaving behind material waste for centuries after its useful life (unlike synthetic plastic, for example). This is an easy way to make clear for **students** the many challenges for which the natural world has already found solutions, that benefit the natural world rather than damage it. This is different from how humans have historically tried to solve problems. Show five minute National Geographic Video: "A brief history of how plastic changed the world." *(15 minutes)*

Image: Clip from National Geographic Video "A brief history of how plastic changed our world."
Image Source:
https://video.nationalgeographic.com/video/magazine/plannet-or-plastic/

2. Introduction Lecture Part II: Are there landfills in Nature? What is biodegradation? Explain for students the meaning and mechanisms of biodegradation. Preview the upcoming activity in which students, in small groups, will be given materials (including samples of biomaterials made in the previous class) and will explore their properties and place them in a composting chamber to observe how they biodegrade over time. *(5 minutes)*

Image: An image that we showed our students to illustrate the ways in which nature has already designed its own packaging, waste-free.
Image source:
https://me.me/i/if-only-bananas-had-robust-natural-bio-degradable-packaging-of-3831845

(If Time) Vocabulary Game: Hotseat. *We had extra time during this lesson to review the vocabulary we had covered in the past three weeks. If you feel that you have time, break students into small groups to play "hotseat." (for rules and vocab cards see end of PDF) (30 minutes)*

Stage 2: Exploration

1. Exploring Materials + Composters. Break students into small table groups and distribute Material Exploration Worksheets (available at the end of this PDF) to paste into their sketchbooks. By pasting this sheet into their notebooks, observations will be recorded and kept as a reference for future classes. Each small group should have a composting chamber with soil in it, and small samples of the following materials: kombucha leather, bioplastic, mycelium, orange and banana peels, wool or yarn, synthetic plastic (a plastic bottle or plastic packaging should be fine), and any other materials your students might want to add (paper,

cardboard, egg shells, compostable plastic, etc.) Each group should also have the following to aid in their material explorations: hairdryers, beakers of water and water droppers, and scissors. This activity can get messy, so put paper down over your tables or have paper towels on hand in advance if you're worried about cleanliness.

Students then fill out their worksheets, applying different treatments to each material and recording their observations. To test how a material reacts to heat, for example, students apply heat with a hairdryer. To test water solubility, drop water using water droppers or submerge the material in the beaker of water. This activity is meant to get students actively handling, manipulating, and making hypotheses about each material, so we encouraged students to try other treatments not on the worksheet. **When** students are done, they place all of their materials in the composting chamber to decompose over the next two weeks. Make sure students make and record a hypothesis in their worksheets about whether or not each material will decompose Fully (F), Partially (P), or (N) not at all. Groups should also label their composting chamber so they can remember which one is theirs when they check it in two weeks to see how materials have broken down. *(45 minutes)*

Image: Students work in small groups to investigate materials' properties.

Stage 3: Reflection

1. 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)*

- Find one item in the room that is made of natural materials and sketch it and/or record notes about it, paying attention to its materiality, durability, form and function.
- Explain, in a written paragraph or drawing, the "plastic problem" —how it came to be, why it is problematic, and possible solutions.
- 3-2-1 Brainstorm: Three things I learned today, two things I'll apply to my everyday life, and one question I have.

Image: Students pick apart mycelium during their material exploration to test for rigidity and pliability.

Learning Plan

2. "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: "There is no material waste in nature – everything is used, repaired and/or becomes food for something else. A thing only lasts as long as it needs to last. What if we designed in the built environment with this strategy? Biomaterials are one way to use materials with this strategy in mind, which will hopefully be confirmed when we see if they biodegrade or not." *(5 minutes)*

Material Exploration Worksheet

Record your observations about how each material responds to the treatment in the corresponding box. Does it rip or tear? Does it dissolve in water? Does it melt under heat? Under "Biodegradable?" you can make a hypothesis about whether or not this material will biodegrade after you put it in your composting chambers. You can write "F" if you think it will fully biodegrade in two weeks, "P" if you think it will partially biodegrade, and "N" if you think it won't biodegrade at all. Then write a sentence on why you think the material will partially biodegrade, fully biodegrade or not at all. For example, "I think it will not biodegrade because it seems similar to a plastic **water bottle which I know doesn't biodegrade."**

Material	Heat	Water	Rigidity/Flexibility	Biodegradable? Why or why not?
Kombucha Leather				
Bioplastic				
Synthetic Plastic				
Clementine Peel				
Banana Peel				
Mycelium				
Yarn or Wool				
Other				

Vocabulary

Terms:

Decompose: To break down into smaller, simpler pieces/molecules

Biodegradable: Capable of being decomposed by bacteria or other living organisms

Compost: Intentional decomposing of organic matter into simpler molecules that can be used as plant nutrients. Can be the act ("I'm composting this"), the place ("I'm taking this out to the compost") or the name for the material resulting from composting ("I'm going to shovel compost into the garden").

To Play "Hot Seat" Vocabulary Game:

1. Print out all vocabulary flashcards from the past three lessons (or make your own!). Make sure all cards have the word written on one side and the definition on the other.
2. One person sits in the "hot seat." She picks a vocabulary card up at random, does not look at it, and holds it to her forehead with the "word" side (not the definition side) facing her classmates.
3. Her classmates then have one minute to describe the word she is holding up without actually saying the word. The person in the hot seat then must guess the word based on the descriptions. For example, if the person in the "hot seat" is holding up the word "biomaterials", her classmates might say, "we made these last lesson, they're usually biodegradable…" You are not allowed to use rhyme loopholes like "rhymes with myo-materials" because it defeats the point of the game.
4. If the person in the hot seat cannot guess the word after a minute, turn the card over for everyone to review and shuffle it back into the pile so that it will come up again.
5. Continue until every person in the group has had a chance to be in the hot seat or until all of the cards have been used and guessed.

Decompose

Decompose:

to break down into smaller, simpler pieces/molecules.

Compost

Compost:

intentional decomposing of organic matter into simpler molecules that can be used as plant nutrients. Can be the act (I'm composting this), the place (I'm taking this out to the compost) or the name for the material resulting from composting (I'm going to shovel compost into the garden).

Biodegradable

Biodegradable:

Capable of being decomposed by bacteria or other living organisms