Materials Matter/Designing and Building with Nature

ABSTRACT

The future of circular design innovation will be driven by a closer look at the nature around us. How might we reduce waste and design with renewable materials? Surprisingly, our answers might be in humble organisms in often overlooked corners of nature that are low cost and easy to bring into the makerspace. Fungus, kombucha, mealworms, algae and the exoskeletons of crabs and insects might hold some answers. As an informal educator working with a range of school makerspaces, libraries and museums, I see a growing desire to engage students in pressing global sustainability design conversations and I believe hands-on biodesign material explorations are a way to develop deep student interest and confidence in exploring challenging environmental issues. The experimental Materials Matters programing I conduct consist of a range of maker activities that introduce biomaterial design and bio-collaborative design concepts to youth (6th grade through high school). I have taught these workshops in the Los Angeles Area and in the San Francisco Bay Area both as workshops and as a week long summer camp.

When inviting students to imagine solutions for a healthier planet, we must first address students' existing material bias; often students come to the conversation with a fear of organisms which may be part of environmental system solutions. It is important to break down these fears with creative craft activities that give students hands on experience with grown biomaterials. If we are asking students to solve environmental issues, we need them to feel first connected to the nature in their local communities. Incorporating local natural materials into maker project can build these connections. It is also important to have staggered living culture growths, careful tracking sheets (to identify ideal growing environments and ideal timing for material harvesting), and to build a baseline student literacy in local waste flow paths. .

Keywords

Biodesign; mycelium; kumbucha; biocollaborative design; biotinkering; circular design; sustainability design; bioplastic

2. DESCRIPTION

2.1 Description of your setting

I develop STEAM programming in my garage makerspace and conduct workshops for larger groups at school makerspaces, libraries, museum and in summer camps. During the past six summers, I have instructed a camp week called "Design Your World" in the AYA Art & Design Thinking Camp in East Side San Jose, California. This camp week invites middle school students to envision sustainable habitats on Mars, reimagine local public community spaces and dream bedrooms. 98% of these campers are eligible for the free-reduced meal plan and 16.5% of adults over twenty five in this area have a college degree (city-data.com). In the summer of 2018, I conducted a week long Materials Matter camp called "Sustainable Prototyping" for teens (11-16 year olds) at the Krause Center for Innovation at Foothill College. It invited teens to study local waste streams flows, explore growing and using bio materials and envision sustainability solutions for local environmental issues. Most recently, I conducted a Materials Matter workshop for sixth graders at the Center for Early Education in West Hollywood. This workshop focused on introducing students to a range of biological building materials that may be useful in the development of new sustainable construction materials and bioplastics. Currently, I am working with a teen girl Biodesign Challenge team in my garage and they are expanding upon the workshops I have developed. This team draws from two public schools and one private school in the Cupertino area of California.

2.2 Description of the educational experience

As part of my Materials Matter programming, I have conducted a three hour biodesign introductory workshop for sixth graders, a week long teen summer camp in Sustainability Prototyping, and am currently mentoring a biodesign team focused on sustainability design solutions for environmental issues. I am intent on exploring ways to bring biology and nature into makerspaces to increase the palette of sustainable materials students work with. If we are to truly address climate change and consumption issues, educators need to create space for students to develop their familiarity with underappreciated corners of nature such as fungus, algae, chitin, and bacteria, as well as organisms they might collaboratively design with, such as silkworms and mealworms. In the sixth grade workshop, students made small table lights and illuminated broaches using mini light shades grown from fungus mycelium. In the summer camp, the teens created bioplastics made of chitin and agar that they poured into small chocolate molds, they explored raising mealworms as plastic digesters, they explored growing mycelium in mold forms, and they created prototypes of their ideas for addressing sustainability issues locally. I have documented some biomaterial lesson plans here: https://nestmakerspace.weebly.com/designing-with-nature.html These hands-on experiences in handling and growing biomaterials gave students a new entry point through which to understand small and microscopic organisms that many previously had negative thoughts about. The teen biodesign team I am currently mentoring is exploring bacterial cellulose as a craft and design material.


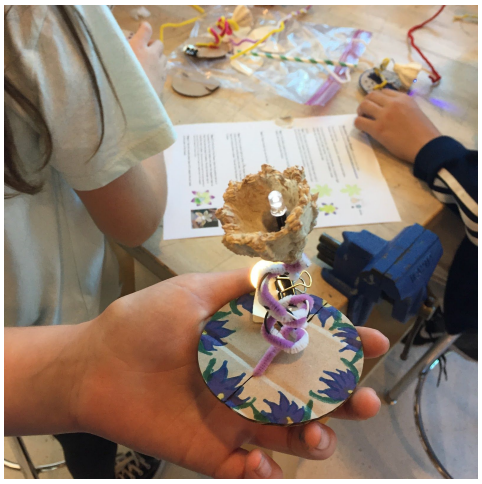

Image 1. Campers identifying local pollutant sources for air and water pollution. Image 2. Sixth grader's fungus mycelium table light.


Image 3. Sixth grader's illuminated broach made with a fungus mycelium light shade. Image 4. Bio plastics of agar and chitin dried in chocolate molds in teen summer camp.

3. CONCLUSION

3.1 Results

In both the workshops and summer camp, students developed a curiosity for materials and organisms that many previously feared to interact with. At the beginning of the camp week, each camper was given two mealworms to care for and feed. At first, many did not want to touch the worms, but after a few days, their favorite daily activity became checking in on their control mealworm and their polystyrene fed mealworm. They did daily journal sketches and documentation of the status of their worms. At the end of the week, most wanted to take their mealworms home with them. I learned that having a microscope in the room was useful in getting students to slow down and really examine the nature material or organism we were working with. Students found that viewing things at a microscopic level could transform something yucky into something that had a range of beautiful complex textures and patterns at different magnification levels. Next time I would design a Sustainable Prototyping camp to last at least two weeks, as one week was not long enough to grow materials and explore prototyping ideas for circular design solutions. It is important to stagger culture growth batches so students can better understand how a culture or an organism colony interacts with its nutrient substrate and how it changes it over time. I pre-grew many of the materials we used and then also had campers start cultures from scratch in the camp on the first day, knowing they would be taking these home to continue their journeys.

While these school embedded workshops did not have broader community impacts, the related free community biodesign workshops I conducted in downtown San Jose and in Palo Alto have. The San Jose workshops reached a large range of ages, communities and education levels as they were conducted in conjunction with a large street festival in which local museums were also free. People were able to create their own mycelium forms to take home and were also able to participate in pressing mycelium incubated bark into large 3D printed molds to grow into parts for a chandelier that was installed in the Tech Museum of Innovation in San Jose. These community pop-up workshops,

The Mycelium Chandelier Grow Project, https://myceliumchandelier.weebly.com/ , led to the development of the summer camp and school workshops. The goal of the project was to engage a broader cross section of people in biodesign conversations so that they could be more informed about biomaterials and feel a part of innovation conversations centered on sustainability.

3.2 Broader Value

We need to bring biology and circular design into the makerspace if we want to deeply engage students in sustainability conversations. Even just the introduction of a microscope into a makerspace can invite students to begin to look at material properties and at their own material consumption more thoughtfully. Such engagement with nature in the makerspaces requires a slowing down to accommodate for bio growing times, as well as a deeper literacy with locally sourced natural materials. As we bring in locally source materials and look to natural building materials, we will also need to look at a broader range of traditional cultural practices for inspiration. Casting the net wider for deeper innovation paths with biology will give us opportunities to engage students through their own cultural traditions and historical practices. There are many innovations in cultures around the world that can inform bio design innovation. For an example, we need not look further than current NASA Mars 3D printed habitat design challenges to see engineering and design inspiration being drawn from Cameroon Musgum dwelling made of onsite regolith.

3.3 Relevance to Theme

While the topics of global pollution and waste reduction can be overwhelming to youth, it is important to engage youth in these conversations. Bio material design explorations in the classroom or makerspace can make the idea of developing solutions to these pressing issues exciting and empowering. There is an opportunity to invite youth into sustainability and environmental design conversations through growing biomaterials and using them in engaging ways. Hands-on exploration of fungus, mealworms, algae and the exoskeletons insects can invite students to imagine new materials to replace the plastics we currently use and can invite students to think about circular design systems that heal our environment. Most importantly, students cannot envision solutions to global environmental issues if they have not already built an appreciation and empathy for the nature in the places they live. We need to take students on maker explorations that offer greater opportunities for connections with the nature around them in their own communities and we need to incorporate biogrown materials into their palette of maker materials. When students experiment growing their own materials to build and design with, they are taking action to thoughtfully looking beyond plastics and engage in environmental issues from a materials consumption and circular design perspective. Growing their own materials, students begin to imagine other uses for such sustainable materials.