Everyday STEAM Objects as Integrative Boundary Objects

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Abstract: As STEAM has gained traction in informal education settings, it is important to support educators in learning about and developing STEAM learning experiences. We investigated what STEAM means to informal educators and how it relates to their everyday lives and identities by examining a STEAM objects activity. We found three themes in how the participants talked about the significance of the STEAM objects they shared: connection to land, historicity, and agency of materials. The STEAM objects served as boundary objects that connected communities of practice, showing the integrative nature of art and STEM, as well as bridging important aspects of their lives and STEAM. We discuss the importance of recognizing and leveraging the multiplicities of meaning and ways of knowing.

Introduction

The integration of art and STEM, or STEAM has gained traction in educational settings because of its potential to broaden participation in STEM (Peppler, 2013; Bevan et al., 2019). Library systems are increasingly offering more STEAM programming in response to interest and demand from their communities (cf., ALIA Australian Public Library Alliance, 2017) and libraries, museums and other informal spaces are offering making and tinkering spaces (Koh, et al., 2018). The informal educators who are designing and facilitating STEAM programs come from a wide variety of backgrounds and bring a wealth of disciplinary expertise to the table, such as a strong background in art, STEM, or library science. However, the integrative nature of STEAM requires navigation across multiple epistemic domains in order to not only understand connections between fields, but to transform and create new ways of knowing and there are currently few formalized professional development (PD) opportunities for informal educators (Bevan & Xanthoudaki, 2015).

This project leverages our work over the past five years to create and provide STEAM PD to informal educators. The PD focused on a set of STEAM practices developed in previous work with youth in informal settings and included helping educators identify strategies for supporting STEAM-linked identities and a STEAM mindset in learners (Carsten Conner, et al., 2017, 2019). We argue that it is important for educators to consider their own connections to STEAM in order to design STEAM programs that support STEAM-linked identities in the learners with whom they work. This paper explores one activity in the PD designed to explore personal connections and conceptions of STEAM. We describe a STEAM objects activity, where educators were asked to bring an object that has personal meaning that was related to STEAM to share with the group. They were asked to share the object's connection to STEAM, and why it was meaningful to them. The purpose of this activity was for the educators to consider the integrative nature of STEAM using examples from their everyday lives. In this paper, we examine how *materials* of STEAM can act as boundary objects to connect communities of practice, such as art and STEM, and STEAM and our everyday lives in order to help participants explore the integrative nature of STEAM. We ask the following questions: (1) what does STEAM mean to informal educators, as reflected in the STEAM objects they chose to bring and share? (2) How do these objects relate to the educators' everyday lives and identities? and (3) How do they see the integrative nature of STEAM in their everyday lives?

Theoretical approach(es)

Boundary objects can connect multiple spaces; they can form bridges between communities (e.g., science and art, school and home communities) (Star & Griesemer, 1989; Cobb et al., 2003). However, boundary objects themselves, do not bridge communities; it is how they are taken up by members of the communities. Boundary objects can also push boundaries (Lee, 2007), such as the boundaries between art and STEM, and transform them (cf., Tsurusaki, et al., 2013). In addition, it is important to examine the importance of the boundary objects, or materials, themselves. *Material culture,* or the "constructed things and spaces around us… become important in helping us understand the values, beliefs, thoughts, skills, qualities, actions, and attributes of the people involved with them" (Blandy & Bolin, 2018, p. 8). We can therefore understand artifacts (and the materials from which they are made) as objects that support people in navigating across epistemic domains and figured worlds.

We also draw on a material agency (White, 2019) perspective to document the distributed and dialectical nature of meaning making and action across people, material artifacts, and histories. Shotter's (2006) "withness thinking" allows us to frame how the relationship between materials and social action emerges and how material

artifacts can signal person's living history, or what Holland, et al., (1997) call acts of "collective remembrance" (p. 61) through materials.

Methods

The context for this study is a PD program that consists of a two day, in-person workshop, a follow-up online mini-course, and support for developing STEAM programming. This paper focuses on the two day workshop for informal educators in March of 2018 in the far northwestern United States and in March of 2019 in the Southwest region of the United States. The participants included educators from a variety of institutions, including 4H, a public library system, and a local science center. Data for this paper come from videotaped observations of the STEAM objects activity. We analyzed the transcripts using emergent coding (Strauss & Corbin, 1998), looking specifically at how participants talked about materials and their relationships to those materials.

Findings

We found three themes in how the participants talked about the significance of the STEAM objects they shared: connection to land, historicity, and agency of materials.

Connection to land

One theme that arose from the educators' stories was the meanings they held in relation to land. One participant, Maria, brought in a paper wasp nest that grew in the doorway of her house. She shared how the wasp nest motivated a program she was developing for youth at her library branch; this program was inspired by and incorporated place and the connection between nature and culture. She was creating a program where youth would study the anatomy and life cycle of paper wasps, make paper, and paint the paper. Paper wasps inspired modern day production of paper because they chew wood into pulp and mix it with their saliva to create their paper nests. Maria explained, "So the first day we're gonna do this [holding up wasp nest] and make paper and then the next time the kids come in, we're gonna paint, we're gonna do Amate painting on the paper that we made." Along with the connection to land through the wasps and wood - which is used to create paper - she also incorporated the interconnection between land and her culture, sharing that she's from Mexico, where Amate bark painting is a traditional art form of creating paper from bark and the paintings often include colorful flowers and animals.

In another example, STEAM materials literally include Lena's own body and represent deep connections to place, memory, and practice:

> I carry my favorite piece of artwork with me everywhere I go because it's on my body. My tattoo. This is a sunflower and I grew up among sunflowers in California and I personally identify with sunflowers a lot. I find a lot of my identity in some of the things that sunflowers are able to do, like take in toxins and create beauty and their seeds are black and they have, exuding a lot of light and actually they're so strong and beautiful and they face the sun. And they follow the sun… And the fact that you can put ink in your body is weird and also really cool. There's a lot of forms… But also it's mine.

Lena starts by referring to her STEAM object, her tattoo, as her "favorite piece of artwork." For Lena, her tattoo is important because it reminds her of where she grew up, which was a land where sunflowers were prevalent. Sunflowers are also important to her for their functions as a plant. She is exploring how her tattoo is both art, science, and represents an important part of who she is. The tattoo, inseparable from her body, literally crosses boundaries with her as she navigates across the different communities of practice in her life.

For both Maria and Lena, their objects held strong connections to land and were tied to their identities, signifying deep nature-culture relations. Their STEAM objects serve as boundary objects, allowing them to explore connections between science, art, and culture. For Maria, her object not only bridges disciplines, but also her everyday life and her work life, and she leverages her experiences and expertise from her everyday life to develop a youth STEAM program for work at the library.

Historicity

Another theme was the importance of history and culture related to the STEAM objects. Susan brought in a sifter from the 1950s and shared how it was a tool in her mother's kitchen, which is now in her kitchen. Susan shared:

> She [Susan's mother] got it as a wedding present and then I have good memories of her making things and then I was 10 years in 4-H so I made tons of things. I now use it to make hot chocolate

> whenever I'm having sleepless night. I've gotten my husband in the habit as well. So I'll sift cocoa, and mixed with Ovaltine so it's my own concoction. So the connection is, it being a tool, part of technology and it also the culinary science aspect of cooking.

The sifter was important to Susan because it was passed on to her by her mother and it was something that she first saw her mother use in her childhood, that she then used as she got older when she used it to bake, and she now uses with her husband. She sees it related to STEAM in its role in making her own "concoctions" and being a technological tool of culinary science.

Cara shared a wall hanging that she was given from Tlingit (1) tribe members when she graduated from high school. She describes how she and her family were accepted into the Tlingit community, even though she was Cherokee and German and had blonde hair. She and her children learned to sing, dance and speak Tlingit:

> So when I was five, my family moved to Sitka. …even though we were German and Cherokee, we were enrolled in the Cherokee tribe and so we were at that time allowed to be a part of the Sitka Native Education program. So, my children were in the womb dancing. And when they came out, they wore this blanket. … And I can put it on the wall, which is what it originally was made for and I took it to college, I hung it in my dorm room. I took it to the Bay, I hung it in my house.

The blanket had special meaning because it represented community acceptance and various stages of her life. It therefore also became a generational artifact that held new importance as she had children. The blanket, a material itself used in dance and other ceremonial practices, held cultural, personal, and intergenerational meaning. While Cara did not specifically talk about how the blanket represented STEAM, she shared it as her STEAM object and focused on the personal meaning.

For Susan and Cara, their objects engaged multiple generations and played important roles in their community practices, such as food and child-bearing practices. This underscores the importance of material objects of STEAM, and how knowing their histories allow for different forms of relations and knowledge systems to be brought into the learning space.

Agency of materials

Kira brought in jewelry made from glass beads she had made. As she describes the jewelry, she describes how the bead making process itself is a mix of creativity, chemistry, physics, and aesthetics:

> I make glass bead jewelry. …these are with silver. And the silver has a reaction with the ivory colored glass. So the different chemicals in the, the silver or copper react with the color in the glass and it's very interesting. Plus …just making glass itself, with the coefficient of expansion, how glass expands and cools and making sure that you don't break glass. … There's a lot of creativity that goes into making something that looks nice. … But then also, you have to, you have to understand the properties of glass if you're going to make something that doesn't break. So, um, you have to understand the temperatures.

This example illustrates how participants saw the agency of materials being part of the connection they felt to them. Kira talks about the glass expanding and cooling, understanding the properties of the glass so it does not break while she is working with it, and how the "silver and copper react with the color". This also illustrates the integrative nature of STEAM itself—how creativity, properties of matter, and aesthetics all come together into the making of this object.

Conclusions and implications

This work stands as a concrete example of how to center the multiplicities of potentials that come from a focus on the cultural and historical meanings of materials within STEAM instruction. One of our goals as equity-focused educators is to move towards more "pluralistic outcomes" (Paris & Alim, 2014) by centering multiple ways of knowing and relating to STEAM rather than an "access only" approach. We hope that this work allows practitioners to see how approaching STEAM through multiple lenses, can lead to more culturally sustaining pedagogies and futures for the learners that they teach.

Endnotes

(1) We deliberately do not blind the cultural context of our research setting in an effort to refuse erasure of indigenous peoples from research.

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