



Ecologizing pedagogical artifacts: teacher learning through art-based collaboration

Deborah Dutta & Miwa A. Takeuchi

To cite this article: Deborah Dutta & Miwa A. Takeuchi (24 Jul 2026): Ecologizing pedagogical artifacts: teacher learning through art-based collaboration, Environmental Education Research, DOI: [10.1080/13504622.2026.2708251](https://doi.org/10.1080/13504622.2026.2708251)

To link to this article: <https://doi.org/10.1080/13504622.2026.2708251>



Published online: 24 Jul 2026.



Submit your article to this journal [↗](#)



Article views: 93



View related articles [↗](#)



View Crossmark data [↗](#)



Ecologizing pedagogical artifacts: teacher learning through art-based collaboration

Deborah Dutta  and Miwa A. Takeuchi 

Werklund School of Education, University of Calgary, Calgary, Canada

ABSTRACT

Despite growing studies supporting the value of art-based environmental education interventions, limited attention has been given to the pedagogical artifacts that underpin such initiatives and their role in shaping environmental learning. We consider how centering the pedagogical artifacts lends itself to deeper reflections about their relationship and embeddedness in the immediate environment. Drawing on participatory-design methodology, our research focuses on the collaborative processes between an artist and a pre-service science teacher, as part of a community-based research-design partnership. The findings indicate how participation in the artist's approach to session design led the pre-service teacher and other facilitators to ecologize pedagogical artifacts along lines of material sourcing, Land histories, frugality, wastage, and reuse. In this process, the pre-service teacher reimagined her teaching aims and practices through increased attention to the local environment. The collaborations made space for emergent teacher learning anchored in embodied experiences mediated by engagements with the pedagogical artifacts. Through centering the design and deliberation of artifacts as constitutive of onto-epistemic experiences, our study illustrates a possible pathway to support expansive pedagogies through art-based collaborations.

ARTICLE HISTORY

Received 19 January 2026

Accepted 19 July 2026

KEYWORDS

Artifacts of practice;
art-based collaboration;
teacher learning;
ecologizing education;

Introduction

The ongoing contemporary socio-ecological crises call for closely attending to the ethical, emotional, and existential dimensions of learning (Vossoughi, Marin, and Bang 2023). Arguing for a radical commitment to develop “arts of noticing” (Tsing 2015, p. 126), scholars emphasize learning opportunities that build on more-than-human relationality, while disrupting the metaphysics of human exceptionalism and separation from nature (Bonnett 2004; Simpson 2014). Terming the approach as “ecologizing education” (Blenkinsop and Kuchta 2024; Bonnett 2020), environmental educators have argued that a critical analysis of the philosophical assumptions underlying the aims of education lies at the heart of the cultural transformation needed to counter

the alienating ontologies of the globalized, industrial societies. Building an ecological ethos requires a radical rethinking of the ways in which we acquire, practice and consume knowledge through participating in relationships that center care, responsiveness, and responsibility. Taking up this call to reflect on how such philosophical orientations might be nurtured in informal learning spaces, we explore a particular manifestation of ecologizing education through attending to the artifacts co-created through the pedagogical practice. Artifacts are considered as both material and ideological from the sociocultural theory of learning (Cole, Göncü, and Vadeboncoeur 2014; Vygotsky 1980). Our use of the term 'artifact' is premised on the intention of creating something for a specified purpose, such that it involves some modification of existing materials (Preston 2022). From these perspectives, artifacts can embody ideological relationships between humans and non-humans. We seek to explore the role of pedagogical artifacts in teacher learning, focusing on the land-based paint material making inspired by a collaboration between an artist and a science teacher. Pedagogical artifacts such as land-based paint material can offer learners a possibility to reflect on and amplify their relationships with the places they inhabit.

Art-based practices to foster ecological sensibilities

Art-based practices, in particular, have emerged as creative pursuits to encourage the suspension of habitual thinking in favor of divergent responses, opening up spaces to consider fundamental questions about nature, place, histories and possible futures (Graham 2007). Art-mediated interventions form a significant, though relatively under-theorized, strand of environmental education research. Artistic practices, such as drawing, painting, sculpture, mural-making, performance, and other creative forms, are increasingly used in formal, informal, and community-based EE settings. As a pedagogical approach, it seeks to integrate artistic practice with environmental inquiry, foregrounding creativity, perception and aesthetic experiences as valued ways of knowing (van Boeckel 2015). Art-based practices encourage exploration, sensory engagement and imagination. Learning, in this perspective, co-emerges with the acts of making, observing, and being in a conversation with environmental phenomena. Within environmental education research, this approach aligns with pedagogies calling for more relational, situated, and experiential forms of learning (Gough 2013; Payne 2018).

In educational contexts, engagement with the arts can nurture experiences and relationships that enable a critical reflection of current realities and open imaginative spaces towards alternative futures (Kagan 2019; Trott, Even, and Frame 2020). Colucci-Gray and Gray (2022) contend that the embodied affordances of the imaginative practices mediated by art support an ontological shift "from the world 'out there' to a world in the making" (p.34). Halverson and Sawyer (2022) explore a range of art-based activities in formal and informal spaces to describe the liberatory, agentic and rich sense-making possibilities made tangible through embodied, situated and collaborative arts practices. Seitamaa-Hakkarainen (2022) further argues that art-based knowledge creation involves non-linear pedagogy as learners gather skills and ideas from diverse sources, often coming up with emergent outcomes instead of pre-determined content. Connecting the potential of art practices to foster expanded

understandings of the nature-human relationship, Liukkonen et al. (2023) explore bio-art making as a way to interact with nature through expansive emotional and cognitive capacities. A study by Flowers et al. (2015) examined the use of children's drawings as both a learning activity and an assessment tool in environmental education. The authors found that drawings revealed nuanced perspectives of environmental relationships, and values that were not easily captured through traditional survey instruments. Similarly, Hallam, Gallagher, and Owen (2022) analyzed an outdoor art-based intervention involving the co-creation of a sculpture in a local park by children and teaching staff to highlight how the process deepened children's knowledge about the plants and fostered empathetic attention to the local environment. Ison and Bramwell-Lalor (2023) explored the process of designing environmental art products by undergraduate students as a pedagogic strategy to foster positive connections with the local environment. A review of art-based research to support human-nature connectedness by Muhr (2020) reveals the need for more theoretical and empirical work exploring the integration of arts with other disciplines through collaboration with artists.

Despite the largely positive effects of art-based interventions, the material anchoring of these practices is less understood, especially from the viewpoint of their pedagogic valence and design, as the process of sourcing, consuming and discarding these artifacts of practice embed certain dispositions and ideologies toward human-non-human relationships. Further, as Burnard, Colucci-Gray, and Cooke (2022) caution, most efforts end up tokenizing arts to amplify the delivery of other disciplinary contents, such as science. They argue that a hierarchical, subservient approach precludes serious dialogues of scientific and artistic processes, in effect denying the desires of learners to draw on their socio-cultural, economic and geopolitical contexts to participate in consequential learning (Hall and Jurow 2015). The mainstream treatment of the arts as a tool for outreach rather than knowledge co-production neglects the ways in which arts have been historically mobilized for social change and kindle transformative initiatives. Our study invites the field of environmental education and the teacher education community to pay more attention to the design of pedagogical artifacts in art-centred activities as transformative tools. Within the formal schooling system, teachers are socialized into the practices habituated to conveying canonical knowledge without ample opportunities to question or push the prescribed boundaries of pedagogical artifacts (Dutta 2023). In this study, we focus on the evolution of material artifacts accompanying and shaping pedagogical practices from a science teacher's perspective to design art-centred activities.

Conceptualizing artifacts of pedagogical practices to ground ecological perspectives

In the domain of environmental education, many studies have highlighted how encounters and emergent relations with everyday material artifacts cultivate ecological awareness by foregrounding entanglement and co-agency rather than human mastery over the environment (Hecht and Nelson 2022; Nxumalo and Pacini-Ketchabaw 2020; Rautio 2013). For instance, Crinall and Somerville (2020) explore the sustaining nature of daily interactions between children and non-humans, through relational ontologies

that shift attention and awe. Nelson and Cowie (2024) analyze students' exploration of an outdoor learning site using photoelicitation methods to illustrate how non-human material elements coupled with students to transform their perception, experience and overall connection with the place. Hofverberg and Kronlid (2018) analyze how the human-material correspondence unfolds in the context of craftwork, where attunement to the materiality of threading and textiles embeds a relational, rather than instrumental process of learning. Foregrounding the ways in which art and STEM are interrelated in everyday artifacts, Tsurusaki, Tzou, and Carsten Conner (2024) conceptualize "STEAM objects" as a pedagogical activity to analyze how educators interact with material agency to make connections with Land, their professions, and historicity. Together, these perspectives consider pedagogical artifacts as co-emergent ecological mediators that open up spaces for embodied, affective, and ethical capacities to perceive, and participate in the world. However, relatively few studies have explored the evolution of artifact design processes and opportunities available to educators to develop the required pedagogical fluidity. Creating these learning environments also requires a creative disposition among teachers and the ability to embrace the uncertain processes that characterize such open-ended explorations (Turkka, Haatainen, and Aksela 2017).

In this study, we seek to explore art-based collaborations, and their role in supporting environmental sensibilities of teachers and facilitators through engagements with the pedagogical artifacts used in the process. Theoretically, we draw on socio-cultural theories of learning to analyze the centrality of artifacts in shaping learning experiences (Cole, Göncü, and Vadeboncoeur 2014; Vygotsky 1980). From this perspective, learning emerges through historically and culturally situated practices, which, in turn, are mediated by tools, signs, and social relations (Vygotsky 1980; Wertsch 1998). Art-based pedagogical practices, which rely heavily on artifact design and use, constitute a complex form of mediated action beyond aesthetic expression. Yet, the material dimensions of these practices are often considered as incidental to other constitutive elements of learning. Socio-cultural approaches emphasize the role of tools in actively shaping perception, thoughts, and possible actions. Within environmental education, art-based activities such as drawing, sculpting or creating other forms of artwork involve sustained engagement with culturally-mediated artifacts that structure sense-making and embed value positions in particular ways. For instance, the choice of using locally discarded materials, or store-bought goods to create an art installation about the environment can't be divorced from the ecological messaging involved.

Socio-cultural theory thus draws attention to the fact that artifacts are not neutral, and embody evolving histories, power relations, and values. Socio-cultural scholars have also argued that the artifacts mediate shared social practices as forms of learning, rather than isolated instructional events (Cole and Engeström 1993; Vossoughi et al. 2021). Attending to the material grounding of art-based practices, therefore, requires examining not only how materials mediate learning, but whose cultural practices and epistemologies are legitimized or disrupted through artistic engagement. A socio-cultural framing invites researchers to analyze the evolving relations between learners and artifacts. This analytical focus on evolving artifacts aligns with environmental education scholarship calling for more situated, practice-oriented, and

multimodal analyses of learning (Dutta and Chandrasekharan 2025; Lanouette 2022; Riley, Jukes, and Rautio 2024).

Focusing on evolving artifacts of pedagogical practices enacted by a science teacher in a non-formal educational setting, we ask – How do artifacts mobilized in pedagogical practices embody educators' environmental sensibilities and relationships with the Land? Further, how does the collaborative development of artifacts between an artist and a science teacher open up ways of knowing and pedagogical orientations? To delve deeper into these questions, we focus on the learning trajectory of a pre-service science teacher, Becca. Becca agentively reimagined her teaching aims and practices following a collaboration with an artist Chanda, in informal learning spaces.

Methodology and context

We draw on methodological approaches from participatory design experiments that foreground the active involvement of participants as co-designers of educational practices and teaching-learning artifacts (Gutiérrez and Jurow 2016). The methodology recognizes the theoretical underpinnings of tasks such as logistics, artifact design, and pedagogical facilitation. The approach helps in understanding the collaborative design process itself as a site of inquiry by positioning learning as a socially, culturally, and materially situated process. This paper is a part of a larger study based on a research-design partnership on a community urban farm in Canada (Takeuchi et al. 2021). The broad idea behind this larger project was to design a summer camp that center on learning with Land (Styres 2011) (www.soilcamp.ca). Most of the child participants have been forcibly displaced from their homelands due to war and other systemic violence. Many of the children were situated in communal and small-scale agricultural practices back in their countries.

Socioenvironmental visions for reconnection to the Land, soil, plants, animals, and each other form the core of our network with teachers, community workers, researchers, youth, and children. This study focuses on the collaboration between a science teacher, Becca and an artist, Chanda (All names are pseudonyms), to examine the ways in which their interactions shaped Becca's subsequent facilitation at the camp. The research process was approved for the Institutional Research Ethics Board and informed consent was sought from all participants for audio and video recordings. Becca participated in SC as a facilitator between 2023 and 2025. SC in 2025 included the participation in community-led events, facilitator training and co-design sessions, implementation of seven designed sessions spanning 3–5 h at the community farm, professional development sessions including fieldtrip to a site significant for the history of settler colonialism. As a team of teachers, researchers, and community workers, we designed activities and facilitated sessions connected to the Land or soil, garden care, and sharing food. We also held a debrief session with all the facilitators and youth leaders to reflect on the day and make plans for the next session. Becca facilitated three sessions, with other sessions facilitated by an artist, an Indigenous Elder, sustainability researchers and practitioners, and urban growers. The plans were often subjected to the unpredictability of the outdoor settings, and figuring out the possibilities required extensive collaboration and coordination amongst all the

facilitators. Co-design aspects involved seeking feedback and ideas regarding specific sessions, some of which transpired spontaneously during the activity (Ishimaru et al. 2018; Mawasi et al. 2023). For instance, another facilitator drew color swatch cards to help children refer to pH color changes when Becca introduced them to pH sensitive natural colors. This resource was incorporated more systematically in the subsequent session.

Becca's interaction with Chanda was chosen as an analytical focus for the following reasons: Becca was one of the most engaged facilitators in 2025, and led design and facilitation for three out of the seven sessions. She joined the project team in 2024, and was familiar with the space and broader values of the summer camp towards nurturing attentive, relational, and embodied experiences with Land. She recently completed her pre-service teacher education courses and started a teaching position in the formal education system. She is a teacher with a specialization in teaching secondary science, and completed a Master's in Biology prior to pursuing teacher education. With her advanced engagement with science, it was particularly insightful to witness how her views as a science teacher change over a period of time in the process of our shared experiences at SC. Becca was also open and comfortable with reflecting on and questioning her teaching experiences, thus contributing to an authentic account based on mutual trust and respect. All sessions were video-recorded, accompanied by photos and field notes. For the study, we reviewed specific video episodes focusing on Becca's facilitation (6.42 h), along with the activity facilitated by an artist Chanda (4.07 h) to explore how the interactions affected Becca's subsequent design and pedagogical enactments. Content logs were created for the videos, and specific episodes that illustrated the use of artifacts designed by Becca were descriptively coded (what artifacts were used, how they were introduced, how the participants used them), based on collective viewing and further corroborated through the interviews. Specifically, the selection of videos was informed by a detailed interview and informal conversations with Becca, in which she described instances that helped her critically rethink the content and materials used in her facilitation. Interviews (1.56 h across two online meetings) and facilitation planning with Chanda also helped understand the pedagogical choices she made for the session. Questions posed to Chanda explored her motivations as an artist, her work philosophy, her views on the connections between Land and art, and specific planning for the facilitation. A social networking group for facilitators was created to help with logistics, share photos, or post spontaneous reflections from different sessions. The chat logs were also analyzed to describe the collaborative nature of the pedagogical design, through informal discussions and information shared by other facilitators in the group.

Findings

In this section, we describe our artist collaborator, Chanda's approach to designing the learning activity and ways in which it prompted Becca to rethink her pedagogical aims and facilitation design by centering art-based practices. The findings also highlight the role of collaborative environments in enabling Becca to experiment with different artifacts and draw inspiration from the Land.

Chanda's approach to designing art-based activity

Chanda is a printmaker and arts educator based in the city where SC was held. Chanda's art focuses on experimental processes, material transformation and thinking through making. Chanda explained that she sees art as a "fundamental part of life and humanity", rather than "a luxury that one can afford only if one has the time or money". For Chanda, art is just part of the way we observe, interact with, and understand the world around us. This idea took a more pragmatic turn for Chanda when she offered online screen-printing classes for people stuck at home during the pandemic. She decided that they would make the inks from scratch and encouraged participants to scavenge from around their homes. She found the process quite empowering:

That's really exciting, because it's kind of giving the power of art making back to people. It's like you don't have to go out and buy something. You can actually make the materials and use what's around you... So I got really curious about inks—how inks have been made historically before our modern inks that are full of plastic. And I just kind of like fell down this whole rabbit hole of inks and dyes, and how these materials work, and the skills that you need to make them and use them. And how those skills are actually like, really, deeply tied to the Land.

The experience led Chanda to reflect on the extensive connections between traditional craft and local geographies, which in turn must have supported the cultures that evolved from the shared practices. Turning to the Land as an inspiration for art also led Chanda to notice what's happening around them in the local community garden, and how they can develop new and deeper relationships with our more-than-human world. Describing the joy of the process, Chanda commented:

It's all about the hands-on embodied learning. So you know, when I physically grow a plant myself, and then I watch it every day, and then I water it, and I harvest parts of it for food and parts of it for color, and then I process the color. And then I create art with that material. It's just this, like, really amazing way to connect with you know, these creatures that we share the earth with. And it's truly transformative, because it's about this experience that you're going through... You're not sitting in a classroom and getting knowledge poured into your brain. It's like you're actually doing it. And it changes you.

Chanda likes to make complex ideas more accessible through hands-on experiences, and believes that plants have a lot to teach us about the Land, our histories, and ourselves. Given the resonance of Chanda's approach with SC's vision of connecting with Land, listening to silenced histories and attuning ourselves to the ecological dimensions of the place (see www.soilcamp.ca), Chanda was invited to facilitate a session at SC, where she conducted an Indigo dyeing activity with participants. Chanda was very intentional about the materials used in the session, and had detailed discussions with the authors to deliberate over the implementation of the activity. The activity involved making print designs on recycled cotton scraps using clay-resist and immersing the cloth in a vat of indigo dye. The children would then be able to observe the dyed cloth turning green and then blue as the dye would oxidize in contact with air. Chanda was keen that participants are able to witness the change

in color. She was careful to use natural materials even in the preparation of the prints, to ensure that the participants could freely interact with the medium:

“The clay is totally safe for the kids. It just has Epsom salt clay and water and some gum arabic. Like, it’s totally safe to touch. So, um, so that I would feel comfortable so they could really get their hands dirty literally with that, and they, they can go off.”

Nitrile gloves were provided for older children and adult participants to dip the clay resist cloths in the indigo vat, as the dye is caustic and can cause skin irritation. However, the children were able to help in rinsing the dyed cloth in water to get the final color. While conducting the session, other facilitators were encouraged to participate along with the children. Spontaneous conversations around dyeing and textile traditions from different countries grew, as many participants and facilitators are immigrants from other countries. An overview of the session and materials is shown in Figure 1.

Becca’s approach to designing activities

Becca facilitated a lesson on composting, which involved an underwear-burying activity to understand how different materials (cotton, mixed polyester, etc) decompose over time in soil. This activity was adapted from a classic cotton strip test used to test soil decomposition capacity (See, for example: <https://www.nrcs.usda.gov/state-offices/montana/soil-your-undies-challenge>). The subsequent lessons, designed in collaboration with other facilitators, were based on using pH-sensitive natural colors. The analysis

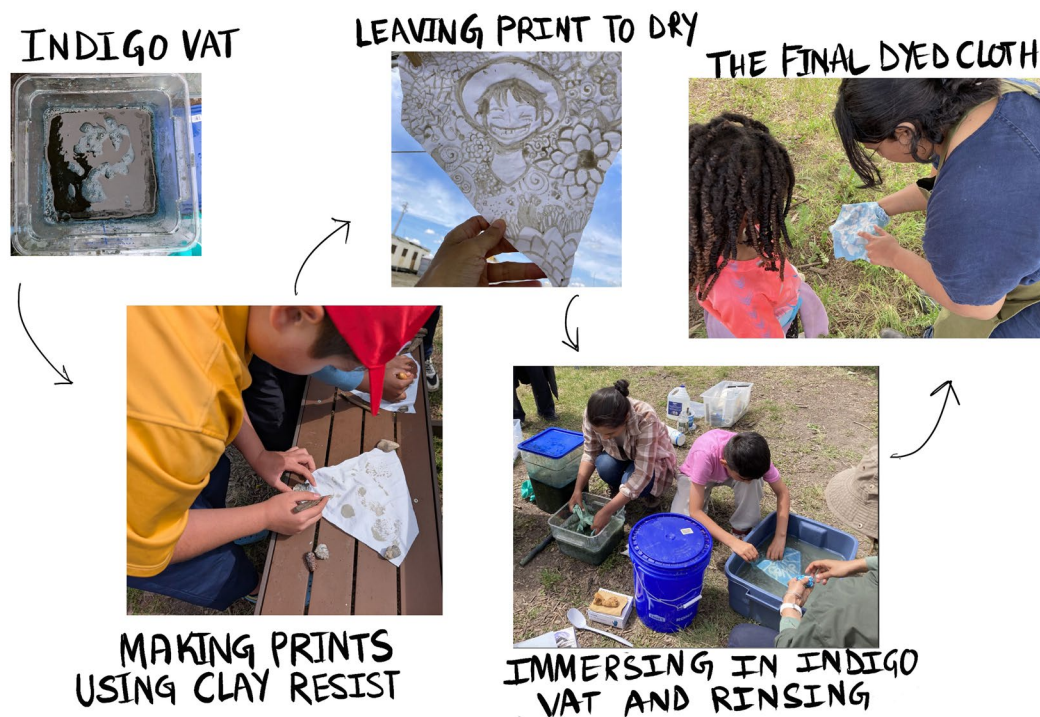


Figure 1. An overview of the Indigo dyeing session.

focuses on Becca’s perspective and design elements before and after her participation in Chanda’s session, highlighting perceived shifts articulated by her. An overview of the session topics and materials used is shown in [Table 1](#). The findings focus on ways that her choice of artifacts and pedagogical outcomes shifted over the course of her experiences at SC, particularly the dyeing activity.

Ecologizing artefacts of pedagogical practices following artistic encounter

The first session facilitated by Becca was called “underwear decomposition activity” in which children would bury unused cotton underwear in the different spots on the Land and discuss the level of microbial activity in the soil based on the extent to which the underwear might or might not have decomposed after two months or so. To explain the rationale behind the activity, Becca began by offering children biscuits and asking them to chew on them and observe any change in the taste. She then went on to explain that digestion begins in the mouth itself, and then gets further broken down in the stomach and gut, which has many microbes. Initially, Becca had made a PowerPoint presentation to provide visual cues and planned to show it on a laptop. However, after conversations with other facilitators, it became clear that it would be difficult for children to see the screen in direct sunlight, since the activities were taking place outside. Becca took large prints of the slides to support her explanation. Despite the richness of the content and the interesting analogies drawn by Becca in comparing the digestive system and the soil decomposition, she noticed children losing interest in the long explanations. The use of many unfamiliar terms, such as “microbes” and “compaction,” also made the explanations a little hard to follow in the absence of repeated, slowed-down, embodied, and emplaced descriptions of key terms for the children, many of whom are multilingual learners with English as

Table 1. Description of artifacts created for different sessions and their pedagogical aims.

Session Number	Session Topic	Artifacts Created	Pedagogical aims
1	Basics of Composting	Printed booklet on human-soil body connection, cotton underwear to test decomposition	Understand what is composting, and gauge factors affecting the composting of a cotton underwear
2	Natural dye painting + Lemonade drinking	pH drawing medium (turmeric powder, lemon juice, laundry soda, butterfly pea flower tea), Lemonade for acid medium and butterfly pea ice cubes as reactant	Observing how natural colors change in contact with acidic or basic medium. Understand the basics of pH
3	Natural dye painting + Collage making + Lemonade drinking	pH drawing medium (turmeric powder, lemon juice, laundry soda, butterfly pea flower tea, onion skin extract, inky cap mushroom extract, cherry juice, red cabbage extract), Lemonade for acid medium and butterfly pea ice cubes as reactant	Observing how natural colors change in contact with acidic or basic medium. Creating a collage using the colours to commemorate activities and associations with SC 2025

a later-acquired language. The next week, she observed the contrast in children's engagement with Chanda's activity when she saw the freedom they had been given to explore with the medium. Commenting on the experience being an important reflection point for her, she said:

"I think it was day three where we did like the dyeing workshop and then just seeing like how excited kids were for that and how everybody like all across all ages were like involved. It kind of made me think like, oh, OK, like this is really cool. Like how do I get like this sort of like level of engagement? And I felt like that lesson was really key for like changing like my approach."

Becca explained that she became more interested in following children's curiosities and appreciating the affordances of the space rather than trying to control specific outcomes. Inspired by seeing children's reactions to change in colors, Becca explored using pigments that would be sensitive to changes in pH values. Rather than using synthetic chemicals, she discussed ideas of deriving natural colors with other facilitators. Some of them suggested that turmeric and cabbage juice are known to change colors in acidic and basic media. Becca then explored more, and intended to use locally available plants as color sources, but was unable to find pigments that would show clear changes in color when interacting with acidic and basic medium. Drawing on Chanda's session, Becca wanted to make artifact interactions the focal points of her activity and selected color sources that could exhibit noticeable changes. In the first iteration, Becca wanted to get into more detailed explanations of pH change, but later allowed questions to emerge more spontaneously based on children's experience with the natural colors, and let the observed phenomena guide subsequent learning. For instance, she went out of her way to make butterfly pea flower (a leguminous creeper native to South and Southeast Asia) extract ice cubes that could be added to the lemonade, and the latter would change color due to change in pH level, turning violet. Becca bought the dried flowers from a tea shop to create the natural color that also doubled up as a drink. She mentioned being inspired by the hot weather and outdoor settings to design a refreshing break that would also act as an opportunity to connect with the dyeing activities. The participants were fascinated by the change in color, and the children dubbed it "galaxy lemonade", observing the swirls of violet forming as the ice cubes melted in the lemonade. The "why" and "how" of the phenomena became much more interesting for the older children once they were able to observe changes in real time. The first author shared with a group pictures of the flower from her homeland (India) in social media group chat., Butterfly pea a native plant in India and these shared photos helped other facilitators make a connection with the color source (Figure 2). Becca's evolving openness allowed her to explore pedagogical opportunities offered by unintended events. Commenting on accidental spilling of a glass of natural color on the table during the third session (See Figure 3) she said:

My favorite moment was just like when Farah was just like dipping her finger in the lemon juice and then drawing on the table and seeing it (blue butterfly pea colour) change... yeah that was like amazing I was just like oh my god like you know you don't plan for this in a lesson but it happened so naturally and you're like oh this is this is what I you know what I want as a teacher ...

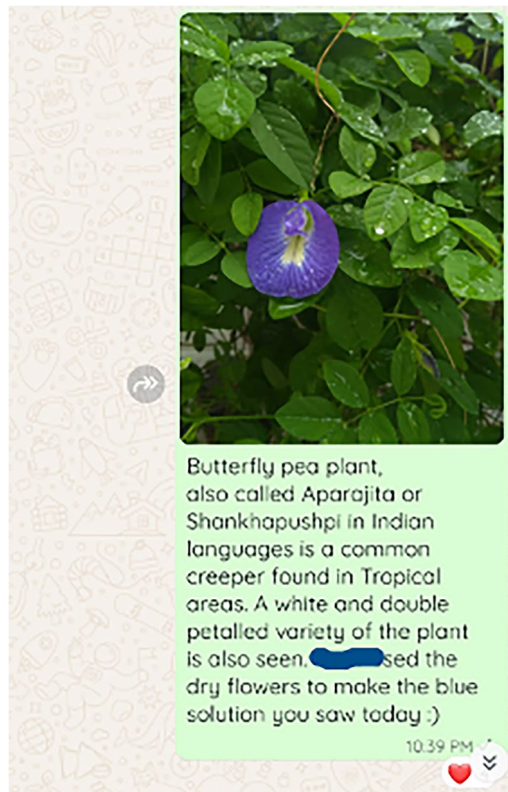


Figure 2. Screenshot from WhatsApp conversation describing butterfly pea flower.

Children were allowed to freely explore different mixing strategies and make their own observations. The materials anchored spontaneous collective learning moments, with other facilitators labelling the inks in different languages. One unexpected observation during the third facilitation session was the attraction of flies to the sweet cherry juice extract, which created patterns as they landed on portions painted with cherry juice (see [Figure 3](#)). Reflecting on how her time at SC had pushed her to think about challenging the centrality of information dissemination, Becca remarked:

You know maybe me focusing so much on just like I want to try to get as many facts and information to kids is not really like you know the shouldn't be like the main or like the like I shouldn't prioritise it as much as I have in the past um and then I think especially like with the art like me engaging with all these like art-based like workshops and SC it's made me realize like how you know a lesson just becomes more interesting when like kids are able to like connect to it and like bring themselves to it because I think often with science it's like we often we give information but we don't give a lot of room for kids to bring themselves to it you know

Becca's reflections point to the complex negotiations involved in ecologizing her personal orientations through pedagogical artifacts, as she revisited her assumptions in teaching aims, and began to consider the immediate environment as a legitimate co-teacher. Different episodes and conversations with facilitators pushed her in generative ways to recognize multiple paths for learning with care and reciprocity.

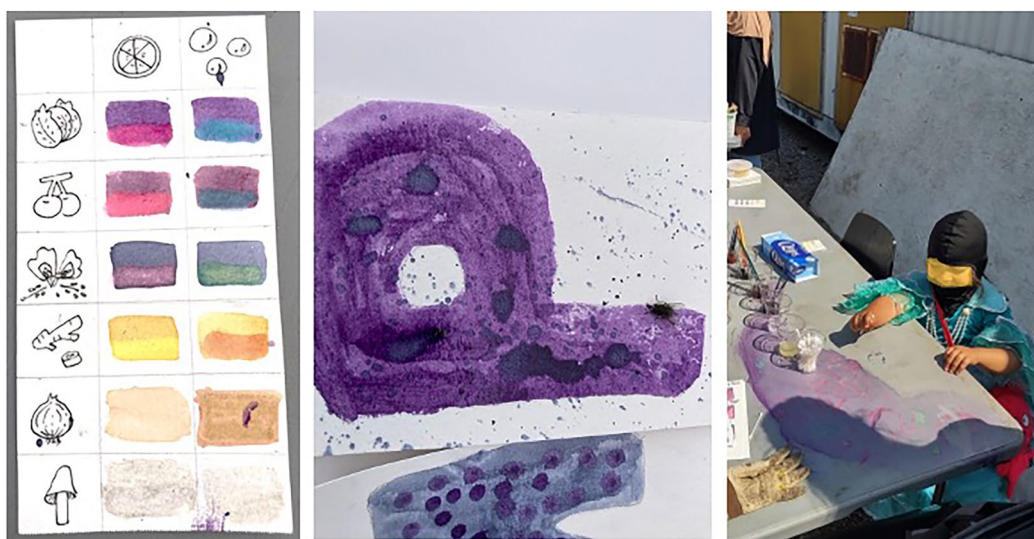


Figure 3. (Left to Right): a colour swatch of acidic/basic reactions by different natural sources; a fly creating patterns on paintings; spilt paint on the table becomes a canvas for Farah.

Refiguring the role of art-based practices through collaborative reflection

One of the initial activities conducted by another facilitator involved creating hand-painted signages for the garden plot. While the activity was engrossing for the children, the use of acrylic paints led the team to reflect on the environmental footprint of the activity. In the field notes, which were shared with all the facilitators, one of them wrote,

The painting activity was attractive for the children, but it is a material-heavy task, with a lot of waste generated in the process... Matching pedagogical intent with the actual enactment is a matter of constant negotiation and reflection, and important for facilitators to thus reflect on possibilities, and constraints with every iteration.

The joint reflection also made Becca think more carefully about the materials chosen for facilitation, and thinking about artifacts beyond the duration of the session. Becca explained that Chanda's session prompted her to think more seriously about the role and significance of art in teaching and learning with an ecological perspective. She commented that as a science teacher, the evaluation priorities prescribed by the curriculum document are restricted to science learning outcomes. She described that, given limited time and resources, teachers tend to use art-based activities either to teach science content or simply as motivational tools. However, after participating in Chanda's workshop, she began to appreciate the significance of art in its own right:

Art can be more than a means to teach science, art in itself can be science. Both art and science can illuminate each other in equal regard.

Becca's reflections on the learning possibilities offered through the activities helped her think more critically about unintentional positioning and the perceived hierarchy between art and science, an unjust epistemic structure that also perpetuates ideas

of humans being separate from nature. Centering the significance of context and relational learning, she remarked how some information could appear appealing to one group, but not another, and that conveying information in ways that allow for personal sense-making is important. Becca felt that art comes with a powerful capacity to create the pathways for sense-making through literal sensory grounding. This view resonates with scholarship examining the situated learning processes involved in art-based learning, and its potential to mobilize art-science collaborations centred on embodied meaning-making (Peppler, Davis-Soylu, and Dahn 2023; Mesa-Jurado et al. 2025). The educational setting at SC also played a role in helping Becca make these connections, as she experienced greater autonomy in exploration and collaboration without feeling bound to specific learning outcomes. The emergent connections with Land helped in grounding and expanding pedagogical artifacts of practice, through collective reflection and sharing. Contrasting the richness of diverse interactions at SC, where Becca exchanged lesson ideas with artists, compost experts, sustainability researchers, social workers, and senior educators, she explained the rigid structure of collaborations typically followed in schools:

I feel like we did have like meetings where it was like we would interact with teachers from other disciplines but I think those were a lot more fewer, and the conversations we were having were like more general around classroom management and expectations... we never thought about like hey I'm doing this lesson; what's a lesson you're doing that maybe we can complement each other

Attending to the artifacts of art-based pedagogical practices

During Chanda's session, Becca and other facilitators noticed how she had arranged for mostly reusable, recycled or upcycled materials such as cloth scraps and wooden blocks for children to draw and paint on. She also ensured that minimal resources were used at the site, such as reusing a tub of water to rinse all the cloth scraps dyed with Indigo, and that the water was safe to pour onto the Land. Seeing these ideas enacted in simple, but effective ways also prompted facilitators to be more reflective about their material sourcing and design. Gradually, through increased attention to artifacts used at the site, frugal sourcing, and minimal wastage became one of the values enacted through session preparation and intervention.

For instance, Becca chose to get large family-pack, recyclable bottles of lemonade rather than small, individual bottles. She mentioned using cherries as a source of natural color because she had found a pack of frozen cherries past the expiration date and did not want to waste them. Similarly, another facilitator collected discarded onion skins from the shelf of a local grocery store to derive color from them. These attempts were shared in the group, and encouraged to pay attention to the local surroundings and materials incorporated in various activities. For instance, an unexpected outgrowth of Inky cap mushrooms (a common fungus growing in disturbed habitats) on the Land following the rains led to an impromptu foraging activity by the facilitators and participants. The mushroom caps decompose into a dark liquid. The color was used for the next iteration of facilitation along with additional naturally derived colors such as onion skin, red cabbage, and cherry juice. Unlike other colors,

Inky cap extract is not sensitive to change in pH, and Becca thought that it would be a nice contrast to other colors. The activity encouraged participants to notice sources of natural colors in the community garden, leading to informal discussions around the use of purple cabbage, beets, and dandelion flowers, among others.

Discussion: reflecting on pedagogical artifacts and teacher learning through art-based collaborative environments

Taking up the task of ecologizing education seriously entails envisioning and enacting different ways of being in the world. Attending to ‘matter’, and why it matters, forms a generative thread of inquiry in contemporary societies characterized by material abundance but impoverished relationships with humans, and more-than-humans. In terms of how attention to pedagogical artifacts reveals teacher relationships with the Land, our findings showed that the collaboration between a science teacher and the artist oriented the teacher to reflect more deeply on the mediating role of artifacts in learning. As Østergaard (2017) comments, meaningful integration of science and art pedagogies require a critical reflection on the hierarchy of modes of knowing, and foreground the aesthetic primacy of encountering the environment through sense perceptions (rather than pre-formed conceptual abstractions).

The artist demonstrated embodied ways to connect with the Land using thoughtfully designed art-based activities. In the process of collaboration, Becca became more interested in designing pedagogical activities that could direct participants’ attention towards the Land and the immediate environment in creative ways. The discipline boundary-crossing experience (between science and art in this case) created opportunities for co-design that were mediated by the artifacts and pedagogical perspectives introduced by Chanda. Pedagogical synthesis of science and arts processes can facilitate grounded and meaningful ecological actions (Colucci-Gray 2019; Kagan 2019; Trott, Even, and Frame 2020). We advance this body of work by carefully attending to pedagogical artifacts consumed and created in collaboration. Becoming aware of the obscured process of sourcing, consuming, and discarding these artifacts can potentially alter human-non-human relationships toward environmental awareness. For the participants, these sessions provided a literal and metaphorical ground for inquiry, anchored in guided attunement with the land. This is not to suggest a linear connection between intervention and increased environmental awareness or action, given that dominant paradigms of consumerism and extractivist discourse of the environment pervade the majority of experiences in everyday life. However, participating in spaces that encourage alternate ways of relating, knowing, and being helped question the taken-for-granted interactions with the Land, and appreciate the interconnectedness with the surroundings. These are not straightforward “positive” experiences, and instead function to complicate the relationship with seemingly common phenomena such as soil, waste, and plants through affective relations (Takeuchi et al. [n.d.](#)).

Becca’s explorations, grounded in the larger themes of SC towards connecting with the Land (Takeuchi et al. 2021) allowed Becca to attend to the artifacts of facilitation, and slow down to favor deep engagement rather than providing information about an established body of knowledge. The intentional pedagogical slowness reflected in Becca’s approach to sourcing and creating the materials as well. She commented on

how she had created the first batch of natural colors just the previous evening for the initial session. However, for the next session she began experimenting with heating temperatures and dilution consistencies a week before, allowing herself to familiarize herself with the characteristics of different materials. In this process of necessary slowness, previously invisibilized labor of material preparation became more evident to her and the community of facilitators. Collectively, we found ourselves being much more careful about using the materials, being aware of the efforts made to create them. After the activity, Becca did not discard the excess pedagogical materials, instead choosing to bring them back and recycle them for her own painting activities. She also expressed interest in making natural-dye paints in the future by creating higher concentrations. The manifestation of attention and care towards the artifact scaffolded a more nuanced understanding of material lifecycles. It also made possible the extension of ecological perspectives beyond specific sessions to include the seemingly mundane tasks of artifact preparation in relation to the Land where these activities were held.

The process then also legitimized and encouraged her to attend to the affective and aesthetic underpinnings of teacher learning (Jaber 2021) through responding to the generative affordances and uncertainty of the outdoor space. However, this was not a solitary effort or journey, as Becca drew on the collaborative space and collective reflections to design various iterations of her activities. Practices of collective debriefing at the end of all sessions and regular peer feedback allowed playful experimentation with pedagogical materials while also fostering deep reflection. For instance, one of the facilitators commented that she did not have to think about the waste associated with art activities when facilitating the sessions in classrooms, as disposal is comparatively easy in those settings. However, collecting the leftover paint and used water on the Land created a stark contrast for her, and she began paying closer attention to other kinds of waste generated as well.

The gathering and designing of the artifacts themselves became an anchor for collective learning among the facilitators. Becca explained that her gradual explorations and material experimentations, along with peers, have inspired her to create similar outdoor activities in her formal space of teaching as well. With a growing moral imperative to recentre educational inquiry along relational, interdependent frames encompassing humans and more-than-humans through networks of reciprocity and responsibility, reimagining teacher agency forms a crucial part of such visions (Hecht and Nelson 2022). This study illustrates a possible pathway to support expansive pedagogies through art-based collaborations, which centre artifacts as constitutive of onto-epistemic experiences (Kayumova and Strom 2023). Enabling educators to participate in, and design diverse “material-experiential interactions” (Liukkonen et al. 2023) can motivate creative and critical modes of learning through attentive interactions with the Land in ways that foreground embodied and relational sense-making.

Author contributions

CRedit: **Deborah Dutta**: Conceptualization, Methodology, Visualization, Writing – original draft; **Miwa A. Takeuchi**: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was funded by the Social Sciences and Humanities Research Council (SSHRC) Partnership Development Grant.

ORCID

Deborah Dutta  <http://orcid.org/0000-0003-2445-7139>

Miwa A. Takeuchi  <http://orcid.org/0000-0003-2640-7506>

References

- Blenkinsop, S., and E. C. Kuchta. 2024. "Ecologizing Education: Nature-Centered Teaching for Cultural Change." In *Ecologizing Education*. Ithaca, NY: Cornell University Press.
- Bonnett, M. 2004. *Retrieving Nature: Education for a Post-Humanist Age*. Malden, MA: Blackwell Publishing.
- Bonnett, M. 2020. *Environmental Consciousness, Nature and the Philosophy of Education: Ecologizing Education*. New York: Routledge.
- Burnard, P., L. Colucci-Gray, and C. Cooke. 2022. "Transdisciplinarity: Re-visioning How Sciences and Arts Together Can Enact Democratizing Creative Educational Experiences." *Review of Research in Education* 46 (1): 166–197. <https://doi.org/10.3102/0091732X221084323>.
- Cole, M., and Y. Engeström. 1993. "A Cultural-Historical Approach to Distributed Cognition." In *Distributed Cognitions: Psychological and Educational Considerations*, edited by G. Salomon, 1–46. Cambridge, UK: Cambridge University Press.
- Cole, M., A. Göncü, and J. A. Vadeboncoeur. 2014. "Experience, Imagination, and Action: Versions of Artifact Mediation." *Mind, Culture, and Activity* 21 (4): 275–277. <https://doi.org/10.1080/10749039.2014.958929>.
- Colucci-Gray, L. 2019. "Developing an Ecological View through STEAM Pedagogies in Science Education." In *Why Science and Art Creativities Matter*, 105–130. Leiden, The Netherlands: Brill. https://doi.org/10.1163/9789004421585_008.
- Colucci-Gray, L., and D. Gray. 2022. "Critical Thinking in the Flesh: Movement and Metaphors in a World in Flux." In *Critical Thinking in Biology and Environmental Education: Facing Challenges in a Post-Truth World*, 21–39. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-92006-7_2.
- Crinall, S., and M. Somerville. 2020. "Informal Environmental Learning: The Sustaining Nature of Daily Child/Water/Dirt Relations." *Environmental Education Research* 26 (9-10): 1313–1324. <https://doi.org/10.1080/13504622.2019.1577953>.
- Dutta, D. 2023. "Whose Subject is It Anyway? Negotiating Disciplinary Tensions in Designing Open-Ended Ecological Pedagogies through an Urban Terrace Farm." *Environmental Education Research* 29 (2): 194–211. <https://doi.org/10.1080/13504622.2022.2104816>.
- Dutta, D., and S. Chandrasekharan. 2025. "We Never Even Touched Plants This Way": School Gardens as an Embodied Context for Motivating Environmental Actions." *Environmental Education Research* 31 (2): 284–303. <https://doi.org/10.1080/13504622.2024.2385993>.
- Flowers, A. A., J. P. Carroll, G. T. Green, and L. R. Larson. 2015. "Using Art to Assess Environmental Education Outcomes." *Environmental Education Research* 21 (6): 846–864. <https://doi.org/10.1080/13504622.2014.959473>.
- Gough, A. 2013. "The Emergence of Environmental Education Research: A 'History' of the Field." In *International Handbook of Research on Environmental Education*, 13–22. New York: Routledge.

- Graham, M. A. 2007. "Art, Ecology and Art Education: Locating Art Education in a Critical Place-Based Pedagogy." *Studies in Art Education* 48 (4): 375–391. <https://doi.org/10.1080/00393541.2007.11650115>.
- Gutiérrez, K. D., and A. S. Jurow. 2016. "Social Design Experiments: Toward Equity by Design." *Journal of the Learning Sciences* 25 (4): 565–598. <https://doi.org/10.1080/10508406.2016.1204548>.
- Hall, R., and A. S. Jurow. 2015. "Changing Concepts in Activity: Descriptive and Design Studies of Consequential Learning in Conceptual Practices." *Educational Psychologist* 50 (3): 173–189. <https://doi.org/10.1080/00461520.2015.1075403>.
- Hallam, J., L. Gallagher, and K. Owen. 2022. "The Secret Language of Flowers: Insights from an Outdoor, Art-Based Intervention Designed to Connect Primary School Children to Locally Accessible Nature." *Environmental Education Research* 28 (1): 128–145. <https://doi.org/10.1080/13504622.2021.1994926>.
- Halverson, E., and K. Sawyer. 2022. "Learning in and through the Arts." *Journal of the Learning Sciences* 31 (1): 1–13. <https://doi.org/10.1080/10508406.2022.2029127>.
- Hecht, M., and T. Nelson. 2022. "Getting 'Really Close': Relational Processes between Youth, Educators, and More-than-Human Beings as a Unit of Analysis." *Environmental Education Research* 28 (9): 1359–1372. <https://doi.org/10.1080/13504622.2022.2074378>.
- Hofverberg, H., and D. O. Kronlid. 2018. "Human-Material Relationships in Environmental and Sustainability Education – an Empirical Study of a School Embroidery Project." *Environmental Education Research* 24 (7): 955–968. <https://doi.org/10.1080/13504622.2017.1358805>.
- Ishimaru, A. M., A. Rajendran, C. M. Nolan, and M. Bang. 2018. "Community Design Circles: Co-Designing Justice and Wellbeing in Family-Community-Research Partnerships." *Journal of Family Diversity in Education* 3 (2): 38–63. <https://doi.org/10.53956/jfde.2018.133>.
- Ison, M., and S. Bramwell-Lalor. 2023. "The Arts in Environmental Education: Connecting Learners with Their Talents and Nature." *Environmental Education Research* 29 (7): 964–979. <https://doi.org/10.1080/13504622.2023.2205062>.
- Jaber, L. Z. 2021. "'He Got a Glimpse of the Joys of Understanding'—The Role of Epistemic Empathy in Teacher Learning." *Journal of the Learning Sciences* 30 (3): 433–465. <https://doi.org/10.1080/10508406.2021.1936534>.
- Kagan, S. 2019. "Artful Sustainability in Transdisciplinary Spaces of Possibilities." *Transdisciplinary Journal of Engineering & Science* 10 (1): 63–67. <https://doi.org/10.22545/2019/01171>.
- Kayumova, S., and K. J. Strom. 2023. "Ontology, Epistemology, and Critical Theory in STEM Education." In *Oxford Research Encyclopedia of Education*, edited by Kathy Hytten. New York, NY: online edn, Oxford Academic, 9 June 2016. <https://doi.org/10.1093/acrefore/9780190264093.013.1508>.
- Lanouette, K. 2022. "Emotion, Place, and Practice: Exploring the Interplay in Children's Engagement in Ecologists' Sampling Practices." *Science Education* 106 (3): 610–644. <https://doi.org/10.1002/sce.21702>.
- Liukkonen, P., H. Vartiainen, S. Pöllänen, and S. Kokko. 2023. "Interacting with Nature in and through Boundary Crossing Learning: A Case of Bioart-Making." *Journal of the Learning Sciences* 32 (4–5): 534–572. <https://doi.org/10.1080/10508406.2023.2263845>.
- Mawasi, A., W. Penuel, A. Cortez, and A. McKoy. 2023. "'They Were Learning from us as We Were Learning from Them': Perceived Experiences in Co-design Process." *Mind, Culture, and Activity* 30 (3–4): 191–208. <https://doi.org/10.1080/10749039.2023.2246039>.
- Mesa-Jurado, M. Azahara, Paula Novo, Rafael Calderón-Contreras, Laura Pereira, Vanya Bisht, Laura Boffi, Cristina Dalla Torre, et al. 2025. "Meaningful Transdisciplinary Collaborations for Sustainability: Local, Artistic, and Scientific Knowledge." *Ecology and Society* 30 (4): 7. <https://doi.org/10.5751/ES-16491-300407>.
- Muhr, M. M. 2020. "Beyond Words – the Potential of Art-Based Research on Human-Nature Connectedness." *Ecosystems and People* 16 (1): 249–257. <https://doi.org/10.1080/26395916.2020.1811379>.
- Nelson, E., and B. Cowie. 2024. "Rethinking Student Agency through 'Material Agency' in the Context of Learning in Nature." *Environmental Education Research* 30 (9): 1535–1551. <https://doi.org/10.1080/13504622.2024.2383749>.
- Nxumalo, F., and V. Pacini-Ketchabaw. 2020. "Staying with the Trouble' in Child-Insect-Educator Common Worlds." In *Urban Nature and Childhoods*, edited by Duhn, I., Malone, K., & Tesar, M., 62–74. London: Routledge. <https://doi.org/10.4324/9780429319723-6>.

- Østergaard, E. 2017. "Earth at Rest: Aesthetic Experience and Students' Grounding in Science Education." *Science & Education* 26 (5): 557–582. <https://doi.org/10.1007/s11191-017-9906-2>.
- Payne, P. G. 2018. "The Framing of Ecopedagogy as/in Scapes: Methodology of the Issue." *The Journal of Environmental Education* 49 (2): 71–87. <https://doi.org/10.1080/00958964.2017.1417227>.
- Peppler, K., H. J. Davis-Soylu, and M. Dahn. 2023. "Artifact-Oriented Learning: A Theoretical Review of the Impact of the Arts on Learning" *Arts Education Policy Review* 124 (1): 61–77. <https://doi.org/10.1080/10632913.2021.1925609>.
- Preston, B. 2022. Artifact. In *The Stanford Encyclopedia of Philosophy*, edited by E. N. Zalta and U. Nodelman (Winter 2022 ed.). <https://plato.stanford.edu/archives/win2022/entries/artifact/>.
- Rautio, P. 2013. "Children Who Carry Stones in Their Pockets: On Autotelic Material Practices in Everyday Life." *Children's Geographies* 11 (4): 394–408. <https://doi.org/10.1080/14733285.2013.812278>.
- Riley, K., S. Jukes, and P. Rautio. 2024. "Relational Ontologies and Multispecies Worlds: Transdisciplinary Possibilities for Environmental Education." *Australian Journal of Environmental Education* 40 (2): 95–107. <https://doi.org/10.1017/aee.2024.23>.
- Seitamaa-Hakkarainen, P. 2022. "Creative Expansion of Knowledge-Creating Learning." *Journal of the Learning Sciences* 31 (1): 138–149. <https://doi.org/10.1080/10508406.2022.2029105>.
- Simpson, L. B. 2014. "Land as Pedagogy: Nishnaabeg Intelligence and Rebellious Transformation." *Decolonization: Indigeneity, Education & Society* 3 (3): 1–25. <https://jps.library.utoronto.ca/index.php/des/article/view/22170>.
- Styres, S. D. 2011. "Land as First Teacher: A Philosophical Journeying." *Reflective Practice* 12 (6): 717–731. <https://doi.org/10.1080/14623943.2011.601083>.
- Takeuchi, M. A., A. Chowdhury, M. Kopparla, S. Thraya, J. Yuen, K. Czuy, T. Mambo, R. Olson, H. Sobh, and A. Fakh. 2021. *Soil Camp: Learning with the Land Toward Refugee Integration, Diversity and Sustainability through Community Partnerships 2020-21*. Calgary: University of Calgary.
- Takeuchi, M. A., D. Dutta, S. Thraya, A. Marin, and T. Mambo. n.d. To Touch the World Through Mushroom Gills: Polyphonic Repertoire of Embodied Relating through Soil-Centered Pedagogy. Manuscript under review.
- Trott, C. D., T. L. Even, and S. M. Frame. 2020. "Merging the Arts and Sciences for Collaborative Sustainability Action: A Methodological Framework." *Sustainability Science* 15 (4): 1067–1085. <https://doi.org/10.1007/s11625-020-00798-7>.
- Tsing, A. L. 2015. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton, NJ: Princeton University Press. <https://doi.org/10.1515/9781400873548>.
- Tsurusaki, B. K., C. Tzou, and L. Carsten Conner. 2024. "Exploring the Integrative Nature of STEAM through Material Objects." *Pedagogies: An International Journal* 19 (4): 596–611. <https://doi.org/10.1080/1554480X.2023.2282980>.
- Turkka, J., O. Haatainen, and M. Aksela. 2017. "Integrating Art into Science Education: A Survey of Science Teachers' Practices." *International Journal of Science Education* 39 (10): 1403–1419. <https://doi.org/10.1080/09500693.2017.1333656>.
- van Boeckel, J. 2015. "At the Heart of Art and Earth: An Exploration of Practices in Art-Based Environmental Education." *Environmental Education Research* 21 (5): 801–802. <https://doi.org/10.1080/13504622.2014.959474>.
- Vossoughi, S., M. Escudé, W. Kitundu, and M. L. Espinoza. 2021. "Pedagogical "Hands and Eyes": Embodied Learning and the Genesis of Ethical Perception." *Anthropology & Education Quarterly* 52 (2): 135–157. <https://doi.org/10.1111/aeq.12382>.
- Vossoughi, S., A. Marin, and M. Bang. 2023. "Toward Just and Sustainable Futures: Human Learning and Relationality within Socio-Ecological Systems." *Review of Research in Education* 47 (1): 218–273. <https://doi.org/10.3102/0091732X231223505>.
- Vygotsky, L. S. 1980. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard university press.
- Wertsch, J. V. 1998. *Mind as Action*. New York: Oxford university press.