

Human-Nature Meaning-Making

Mothers and Daughters Rethinking Humans' Relationship with Nature through Critical Constructionist Design

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ABSTRACT

As its core, the environmental crisis demands humans to critically reflect on their relationship to the natural environment. This case study explores how three mothers and daughters from different ethnic and cultural backgrounds understand nature as they express their relationship with it in the context of a low-tech maker workshop. The maker activity used Critical Constructionist Design to engage participants in a cycle of connecting back to personal and family histories, reflecting on personal circumstances in order to project forward to design alternative futures. Results show how the experience provided participants with opportunities to uncover, reflect on, and re-shape their relationship with nature in search of more fluid and less dualistic ways of coexistence. The findings contribute to understanding how critical frames of making can engage people in critically thinking about today's pressing environmental challenges and underlying human-nature history of separation.

KEYWORDS

Constructionism, critical design, low-tech, making, feminist theory, sustainability.

1 Introduction

Although global warming represents a threat to humanity as a whole, its impact is unevenly distributed. Projections indicate that the effects of extreme weather and the collapse of natural environments will broadly exacerbate existing inequalities [10]. Because of higher exposure to climate hazards and pollutants,

rights' restrictions, limited access to resources, and forced displacement, rural women and girls are among those most vulnerable to the effects of climate change [9, 17, 22, 23].

While world leaders disentangle strings of power and money in search of a solution, women and girls in rural areas are at the front-line of the climate crisis, building resilience, and coping with uncertain environmental changes caused by the recklessness behavior of others. While "women environmental sensibility should not be assumed," historically, they have played a central role in the conservation of ecosystems and adaptation to changes moved by ancient knowledge and strong incentives to preserve natural resources [17:9]. Nonetheless, systemic social, economic, and political structures prevent them from acting, seeing them as victims rather than agents while discounting their knowledge founded in endurance, tradition, and experience. Furthermore, the underrepresentation of women in environmental decision-making in science, business, and governance [17] perpetuates the invisibility of women's challenges. While women's voices are essential at all levels—from local decision making in rural communities to environmental policymaking—this paper focuses on the inclusion of female's perspectives and experiences in science, technology, arts, and engineering (STEAM) for human-nature integration.

Feminist perspectives in STEAM can "correct both the invisibility and distortion of female experience in ways relevant to ending women's unequal social position" [12:71] while counteracting predominant dualistic and disconnected constructions of the self in relation to others and the natural world [7]. However, female visions of human-nature integration are not likely to arise only by including more women in STEAM; instead they need to be built upon women's perspectives, struggles, and experiences. This research sees STEAM education as (a) construction where new understandings are built upon the rich foundation of women's knowledge and girls' personal experiences, and (b) emancipation where power structures that generate social inequalities and environmental instability are visualized and questioned. In this view, the empowerment does not come from accessing technical skills or resources but rather, from appreciating the value of personal experiences and becoming aware of injustices and social constraints [6].

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As a starting point, this research uses Critical Constructionist Design (CCD) [8] as a pedagogical framework to explore how women from different ethnic and cultural backgrounds across two generations understand nature and how they envision humans' relationship with nature in the future. Uncovering the evolving and personal meaning of nature is the first exploratory approach of the Human Nature Project, a research endeavor that aims to advance in the development of transformative learning experiences for humans to rethink their relationship with nature through the exploration of the intersection of design with science, and technology.

CCD combines features from critical design and constructionism to engage learners in critical thinking through making activities. Constructionism has mainly been examined as a framework to explore ideas and concepts from mathematics, science, technology, engineering, and language arts. However, there is little research on how constructionism can facilitate critical reflection on social, political, and ethical issues and their interaction with STEAM domains. Ratto [18], explored critical making with Arduino physical computing for learners to reflect on critical information issues such as intellectual property and privacy. Holbert, Dando, and Correa [8] used CCD to engage African American students in the construction of Afrofuturist artifacts that rethink technology according to their values and history. This research moves the attention from media and race towards environmental justice by using CCD for mothers and daughters to think critically about their relationship with nature through making.

Using CCD as a framework for making the purpose of this case study is to explore:

- What are mothers' and daughters' past experiences with the natural environment?
- How do past personal experiences shape participants' relationships with nature in the present?
- How do participants imagine humans' relationship with nature in the future? How do these visions connect with their past and present experiences?

2 Theoretical Framework

2.1 Critical design: Design for thinking

Critical design uses the language of design not provide direct solutions to the problems we now face, but instead to open more questions, expose assumptions, and encourage reflection [19]. Through the design of unprovable artifacts, it aims to "contribute to the proliferation of multiple worlds existing in the collective imagination, enlarging it to provide a richer conceptual space from which to uncover alternatives to the present and consider the kind of world(s) people wish to live in" [5]. The resulting proposals are artifacts conceived as tangible statements or invitations to think.

Finding harmonious alternatives to co-exist with nature has inspired designers, engineers, artists, scientists, and thinkers in the last decade. As McQuaid curator the 2019 Design triennial exhibition "Nature: Collaborations in Design" explains, "it is no longer 'natural versus artificial' or 'humans versus nature', but humanity as an integral part of nature with each mutually affecting

the other: *We are nature*" [13:8]. For instance, in order to enhance empathy towards other creatures and take a break from the complications of being a human, the designer Thomas Thwaites [20] engaged in a physical, psychological, and cognitive research to transform himself into a goat. Alternatively, the social scientist Rafi Youatt [24], argues that anthropocentrism and species boundaries are at the center of global environmental issues and, by envisioning how interspecies politics would look like, he aims to shift power dynamics between humans and other beings in mutually supportive ways [24]. Artists Catts and Zurr [1] explores the life sciences, or the manipulation of living matter, for the purpose of storytelling while challenging the economic, factual, and instrumental purposes that usually drive science. These are just a few examples of the ways critical design bridges disciplines to spur debate around humans' positionality in nature.

2.2 Critical constructionist design: Making for thinking

In the context of education, critical design can be facilitated in constructionist learning environments [8]. Constructionism aims to engage and support learners in expressing and sharing ideas and knowledge through the means of artifacts of personal value [16]. Constructionism assumes that knowledge construction, and therefore, learning happens in the active process of making such public artifact. Consequently, in CCD the focus is not only in the resulting artifact (as in critical design), but also on the learning affordances of the act of making it. In words of Ratto [18], in critical frames of making the focus is on "the making practices themselves as processes of material and conceptual exploration."

To facilitate this experience, CCD engages learners on iterative activities of reflection, ideation, and making oriented toward critical analysis of past and present circumstances through the projection of artifacts that represent alternative realities (figure 1). Holbert, Dando, and Correa [8] described CCD as a learning praxis that invites learners to (a) connect to the past by tinkering with personal and family histories, (b) reflect on the present by challenging existing inequitable systemic structures that are felt locally and personally, and (c) project forward to create alternative futures where science and technology center their experiences, perspectives, and values.

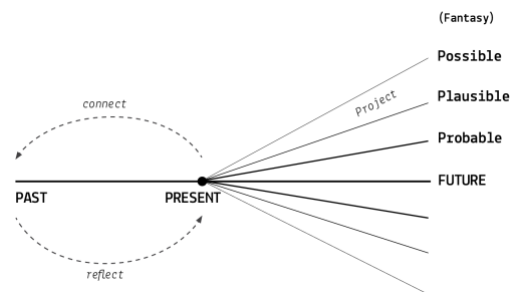


Figure 1: In a CCD practice, designers engage in a cycle of connecting back to personal and family histories, reflecting on present experiences and local systems in order to project forward and create alternative futures.

3 Methodology

3.1 Case study

This qualitative case study explores a CCD workshop as an intrinsically bounded unit of analysis [14]. The six-hour workshop and research implementation occurred in an art studio at a University Campus in New York City. Participants used clay as an expressive medium to facilitate reflection through each phase of the framework. The decision to use clay was inspired by Seymour Papert [16], father of constructionism and advocate of computers, turtle-bots, but also sandcastles as valuable means for constructing knowledge. Because of its low technical barriers and high expressive qualities, clay was an ideal low-tech or “a simple, unsophisticated, uncomplicated, and primitive technology” [21] for smooth and fluid visualization of stories and reflection on their social, political, and ethical implications.

3.2 Settings and participants

Participants included three dyads of mothers from different ethnic and cultural backgrounds and their respective ten-year-old daughters (Table 1). All names are pseudonyms. While limited in number, the diversity of the sample aimed to ensure ethical validation by questioning narrow moral assumptions about humans’ relationship with nature and giving equitable voice to diverse experiences [2]. The inclusion of a negative case [2] among them (one dyad that had minimal experiences with nature) provided disconfirming evidence to portray a more realistic and complex picture of humans relations with the environment. The goal of having a cross-cultural sampling is to broaden our understanding of possible human-nature relationships in specific socio-cultural contexts rather than attempt to stablish normative differences across historically defined cultural communities.

Table 1: Participants and background

Mother	Daughter	Place where mother grew up
Nan	Mimi	Japan, Semi-urban
Trista	Zita	Zambia, Semi-urban
Paula	Antonia	Chile, Urban

3.3. The Human-Nature workshop

The workshop consisted of three parts, one for each phase of the CCD framework.

3.2.1 Connect to the past: The goal was to share and play with personal and family histories about nature. In this phase, mothers received one pre-workshop questionnaire about their childhood experiences with nature. Upon arrival to the study, participants gathered for a photo-elicitation activity around a set of photos that mothers sent, and that represented the places where they grew up. Then, mothers and daughters were invited to work together in making a clay model to represent the place where mothers grew up. Brown clay was used for natural elements and black clay for

human-made things. After that, in a group interview, participants shared their models and associated values and beliefs.

3.2.2 Reflect on the present: The goal was to question and re-shape their clay work in light of their experiences and environmental changes. In this phase, dyads re-shaped their models to represent the place where mothers grew up as it is now. After that, participants shared their models and associated reflections in a second group interview

3.2.3 Project the future: The goal was to rethink how humans relate to the natural world by designing a future-thinking artifact. In this phase, dyads used colored clay to design an artifact that represented a utopian or dystopian way of living in the future. After they finished, they shared their models and ideas about the future in a third and final group interview.

3.4. Data collection and analysis

Multiple data sources were used for triangulation and layering. Data was collected through each activity of the workshop through instruments that included the pre-implementation questionnaire, the group photo-elicitation activity at the beginning of the workshop, the three group semi-structured interviews (at the end of each phase), photos of in progress and final artifacts, video and audio recordings of the whole experience, and field notes taken by the author and three research assistants acting as facilitators and participant-observers throughout the workshop.

The data analysis consisted of several stages. First, audio recordings were transcribed manually to get a general feeling of the experience. Second, data from all sources was analyzed chronologically to identify trends that characterized the participation of the group in each phase of the workshop. Third, data was coded using NVivo to identify emergent categories and subcategories. Fourth, categories were clustered into four themes that characterized each phase of CCD, respectively—nature as free exploration vs. nature as a privilege, nature under control, and human-nature continuum. Participants did member checking [2] by revising the draft of analysis and interpretations to check the accuracy and credibility of the account.

4 Findings

Together, the questionnaire, group interviews, artifacts, and observations of the making process provided a picture of the fluid meaning of nature. Each phase of the CCD framework—connect with the past, reflect on the present, and project the future—guided participants through a journey where they shaped and re-shaped their relationship with nature. As participants shared stories and explained their models, it became apparent how nature was not a singular entity but instead a personal reality constructed through experiences with it.

4.1 Connect to the past: Nature as free exploration vs. nature as a privilege

Nature as free exploration was a common trend in the first phase of the workshop that invited participants to connect with the past. In this phase, dyads used two colors of natural clay to make scale

models of the places where mothers grew up (Figure 2). A stream of stories emerged naturally from mothers to daughters as they attempted to give shape to a place that was only accessible through the retrieval of memories. Daughters, instead of rejecting the stories, were avid to listen, laughing, asking for more details, and corroborating if what they were making resembled their mothers' experience.

Despite their different backgrounds, for all mothers, nature was correlated with free exploration in one way or another. For Nan, growing up in the skirts of a Japanese city, nature was the endless exploration of the woods behind her house. While shaping the clay, Nan emphasized that, while the woods were not part of their property, "it was open," and she "could go there every day." When she wanted to be alone, she would go to the forest and climb a tree, and her parents would find her later on. Mimi, who enjoyed making tiny things with clay, made a nest as her mother narrated about "climbing to the roof and see the birds that made a nest, and then see the little chicks growing!"

Similarly, Trista's memories growing up in a semi-urban area of Zambia were rich in sensory detail, abundant in free play, and limitless exploration. For her nature was "whatever we could get our hands-on" in the vast yard where she mingled among cats, dogs, hamsters, trees, a flower garden, a vegetable garden, and an orchard. She shared the joy of simple pleasures: "Sometimes a fresh tomato was your snack, you just go to the garden, get a fresh tomato, wash it, cut it, put salt on it, and that was your snack." However, Trista's free exploration was bounded by a profound "respect for the wild" and a sense that nature, especially in Africa, is also beyond human control. She realized about this at a young age when, during a family trip to the Victoria Falls, they were almost dragged by the water that unexpectedly changed direction.

While nature was almost absent in Paula's memories growing up in Santiago de Chile, she also mentioned its correlation with exploration. She explained that one of the reasons behind this absence was that her parents gave "little importance [...] to the role of exploration of the natural environment in human development."

For Paula, nature was a privilege out of reach throughout her childhood. She explained that her family was "significantly detached from the natural world" because her parents "worked long hours" and "had other struggles ... like eating and trying to solve other things." For Paula growing in the city was coupled with what

she described as the "loneliness of growing between buildings." She confessed: "I was most of my time... trying to grow by myself with my imagination." Nan, noticing how her memories differed, added to the conversation: "I feel privileged now being able to explore on my own as a child."

For Paula and Antonia, it quickly became clear that their model was mostly made of black clay. Paula explained that "In the city, there were big streets and avenues surrounding my building. At night there was so much traffic and noise... I recall the dryness of the city, the pollution." Paula dug deeper into her memories in search of anything alive among the rough city until suddenly glimpses of nature emerged rich in sensory detail: "I have memories of a few trees across the streets where chamomile grew in the wild. I remember the smell of chamomile at the bus stop."

4.2 Reflect on the present: Nature under control.

Present circumstances in Paula's experience reinforced the elusive character of nature. In the second phase of the CCD workshop, dyads were invited to re-shape their model to represent how the place where mothers grew up looks like today (figure 3). Paula and Antonia's model completely changed at the end of the second phase. Surprisingly, it seemed to be more brown clay this time. Paula explained: "My house was ... torn down and then they built like hotels and businesses. And then, the road stayed, and they made a little park here (pointing to the front of the model), and we added pollution to the mountains." Paula shared that they were "pushed away" from that area because everything got extremely expensive. By the time the workshop took place, Santiago was under severe social unrest, masses of protesters gathered nearby the area depicted in the model claiming for dignity and tired of the increased inequality that affects the country. Paula's experience and the fate of her neighborhood are representative of a history of social injustice. When asked about the potential feelings of people who used to live there, Paula said: "I think [people] feel intimidated by this type of constructions." She further added: "In the name of progress sometimes there are lots of changes in the city. And sometimes, that pushes people away, as it did with us."

Such progress, while apparently positive for the city, did not reach Paula's family, not even through the new park. She shared: "...when they are making a park that is good for everyone to use



Figure 2. From left to right: Nan/Mimi, Trista/Zita, and Paula/Antonia's models of the places where mothers grew up. Black was used for human-made things and brown for nature.

and it's really to benefit the people... but what people are benefiting? the people that can only afford that kind of neighborhood so... it's complicated." Indeed, while there was more nature in the model it represented a place that was no longer accessible to them. Antonia said she preferred the place as it was before "because it had like a neighborhood feel and now it's just like nobody would live there."

The access to nature through parks was also a common trend in the girls' lifestyle growing up in New York City. This controlled access to nature contrasted with the childhood experience of Nan and Trista. For the girls, nature was far more restricted and limited to managed environments. They could not recall playing outdoors by themselves and avoided wild places that could look "like scary places in stories." For instance, Antonia shared: "I really don't like to be deep in the woods but if it is a park or somewhere where it's surrounded by other people in nature then it's ok." Similarly, Mimi explained that even though the wood behind her grandparents' house is now cleaned from "annoying bushes," she avoids playing there: "because there were bugs and [she] was like no! no!"

The idea of nature as a controlled environment became especially apparent through changes in the proportions of the two colors of clay. For instance, while Trista and Zita's model remained almost the same, it was possible to see some trees replaced by a new house that was added within the property to fit the growing family. With sorrow, the old dog was transformed into a new tree by using the same piece of brown clay. This way, the clay allowed to make visible not only the advancement of human's influence over nature but also the ongoing transformation of nature.

Everyone agreed that there was "more black stuff" in Nan and Mimi's model of the present. Nan explained that "the place where [they] used to play with fireworks is now a parking lot" and the forest was cleaned from bushes and transformed into a more open space that "looks more like a park." In other words, it was made into a more organized and domesticated natural environment. Nan regretted that, as a consequence, it was not possible to see wild animals, such as the Japanese raccoon, but she still preferred it as it is now. Mimi, who used to visit the place during summers, agreed and preferred the woods "clean" and "not gloomy anymore."

Nan also explained that in Japan, people are familiar with "a very compact kind of nature" or controlled environments such as urban farms or parks where they can go as a choice. She explained:

"We appreciate the convenience in the city, and we choose to be exposed to the natural environment based on our own comfort." Nan also had a profound understanding of human dependency on controlled natural resources. She shared that her great-grandma survived times of war because she was a farmer and had rice to eat every day. Furthermore, she recognized a more dialectic relationship between humans and controlled nature, in which humans nourish the crop while the crop nourishes humans. For example, since she was young, her parents would take her to the rice paddies to participate in the crop. This way, she was taught not to waste what nature provides: "It's not a thing we can just pay and get at the grocery store. [...] farmers had a lot of work to do to make the product, so we shouldn't be wasting the efforts, and it's also bad for the crop." When she added: "You can see that Mimi never leaves food," Mimi replied in a soft voice, "I do..." signaling a possible discontinuity from her mother's practices and the framing of her own identity in relationship with nature.

4.3 Project the future: Human-Nature continuum

The idea of nature under control evolved into a more symbiotic relationship in the third phase of the workshop. The third phase invited daughters to imagine "an artifact from the future that traveled in time 30 years from now inside a tin" (figure 4). They had to choose between making a utopia—where people will live in harmony with nature and different creatures will help each other to thrive—or a dystopia where—people will separate from nature trying to control it and use it for their own purposes. Mothers were encouraged to collaborate in both ideation and making.

In Nan and Mami's future, the boundaries between nature and humans were blurred. Mimi took leadership by making an under-the-water house re-using one leftover cup from the clays. Meanwhile, her mother helped with the background following her instructions. Inside the house, a girl sat on a couch, "drinking coffee and relaxing with the pet dog." According to her, there will be no more space to live in the land, so people will move into the ocean" and live "inside of the nature with other species." When asked about whether that was regular coffee, she continued making up her story as she talked while shaping the clay: "It's coffee made up of things from the sea." However, for Mimi, the land will not be abandoned entirely; instead, she explains, "we thought that somehow the land



Figure 3. From left to right: Nan/Mimi, Trista/Zita, and Paula/Antonia's re-shaped models of the places where mothers grew up as they look today.

and the water are still connected [...] so the person can go out and get [things]!"

Similarly, in Trista and Zita's future, "people are closer to nature" living inside trees and rocks that sit nearby a blue river. As Zita explained, "people are cutting down trees and stuff to make houses. So, what if they didn't cut down the trees and lived in the tree?" This way, Trista explained, people "are blended with nature" and they also "learn how to build houses in the rock." People in the model had different skin colors, and one of them wore a red dress with a big heart. According to Zita, people are taking walks, collecting flowers to dye their clothes, or getting berries to eat.

Paula and Antonia's artifact aimed to counteract their family history of separation from nature. Antonia explained that in her future, people would "dress in like clothes that are made from natural items like seaweed, weeds, or my mom says a fishbone!" To represent this idea, they designed an orange sewing machine made of 100% recycled materials with a long green piece of fabric made of a bunch of natural materials. Paula added that while she had a poor relationship with nature in her childhood, this idea represented the new direction she wants for her family: "We were discussing how as a family, we should decrease and shrink like everything needs to decrease, we cannot keep growing at this pace."

5 Discussion and Implications

CCD leverages the inherently social and cultural qualities of making to provoke reflection and discussion on today's pressing challenges. Findings show how each phase of the CCD framework provided opportunities to uncover assumptions, recover family values and beliefs, and open up the possibility of recreation. Each phase built on the previous one to construct tangible representations of alternative futures grounded on reflection and awareness.

First, *connecting with the past* through the construction of physical representations can facilitate awareness of values, practices, and beliefs. The materials of construction played an important role in this process. For example, shaping the clay created an intimate atmosphere that encouraged the elicitation of

memories and provided a pace for storytelling. The resulting models visualized family histories to each other which encouraged discussion across dyads. The two colors of clay on each model emphasized differences that invited reflection and conversation. This way, family values toward the environment emerged in stories marked by cultural, geographical, and economic differences.

For participants, visualizing their assumptions was also a process of becoming aware of them. Critical design posits that awareness of the values, beliefs, and attitudes that we hold is the first step toward redefining our relationship with the world around us [4]. For instance, it became apparent how personal relationships with the natural environment were significantly shaped by culture, learned at home, and transmitted from generation to generation. However, as Despret says, "to inherit is not a passive verb, it is a task, a pragmatic act [...] It makes us capable, or not, of something other than simply continuing" [3:178]. This was further illustrated by continuities and discontinuities between mothers' and daughters' practices and beliefs, which were the result of unique personal memories and experiences in different contexts. This way, to remember experiences and values is also an act of reconstructing them. In words of Despret, to re-member is "to create stories, to make history, is to reconstruct, to fabulate, in a way that opens other possibilities for the past in the present and the future" [3:178].

Second, *reflecting on the present* through making can allow for the visualization of changes over time and reflection on present circumstances. This was clearly illustrated through the malleability of clay that permitted to re-shape the models to see changes which added new layers to the discussion. For participants, the advancement of human settlements was not strictly negative, and the augment of nature was not necessarily better. Indeed, girls had a preference for both models that presented more black clay after re-shaping. In both cases, having nature under control, only accessible when desirable, and at the service of people's needs was perceived as preferable. On the other side, the model that presented more brown clay in the re-shaping activity revealed the privileges associated with accessing nature in the city. This way, the complexities of human-nature relationships became visible,



Figure 4. From left to right: Nan/Mimi, Trista/Zita, and Paula/Antonia's future-thinking artifacts

highlighting the primary motivation of critical design, which is to create “tools for thinking; [to] raise awareness and perhaps understanding of substantive and often debatable issues” [19:51].

Third, *project the future* through the design of future-thinking artifacts can open up the solution space for alternative visions that are not recognized today. However, more research iterations are required to help facilitate the integration of past experiences in the design of alternative futures. For instance, in Mimi and Zita’s future-thinking artifacts, the connection between past, present, and future that CCD aims to facilitate was not entirely visible as they seldom reflect on family history, values, and beliefs. Despite that, the three artifacts displayed female, holistic, and less dualistic ways of relating to the natural world. In Mimi’s under-water environment and Zita’s houses inside the trees, it is possible to see how the boundaries between human-made and nature-made elements fade away, allowing more fluid relationships. Through playful imaginaries, they represent how “the female construction of self in relation to others leads in an opposite direction—toward opposition to dualism of any sort, valuation of concrete, everyday life, sense of a variety of connectedness and continuities both with other persons and with the natural world” [7:45].

Similarly, Antonia’s use of natural materials to create clothes manifests a desire to decenter humans and reduce their impact on the planet. Her vision of the future also does integrate her family history as it represents an attempt to shift direction toward more sustainable practices. This exemplifies how in critical design by considering their own preferable future, regardless of its probabilities, people can become aware of their capacity to influence it [11]. Together, the three utopian visions of the future envisioned by the girls, challenge our current practices and prevalent apathy while claiming to become real and erase the possibility of disappointment.

Moving into human-nature integration is not only a scientific and a technological challenge but also a cultural and a moral one [15]. Together the three steps of the CCD can facilitate conceptual exploration and critical thinking on pressing issues we face today as society, such as the environmental crisis and underlying human-nature history of separation. This way, critical making practices, such as CCD, expand the scope of constructionist pedagogies to facilitate critical thinking through tinkering with social, cultural, and historical experiences. Furthermore, future research should consider the potential of critical frames of making as entry points to STEAM learning around other contended socio-political topics and inviting other non-dominant groups in ways that are personally meaningful and connected with learners’ histories and knowledge.

6 Conclusion

This case study explored mothers’ and daughters’ experiences with nature and their influence in their present and future visions of the ecosystem. In the context of a CCD workshop that used clay as an expressive medium, it was possible to observe how the meaning of nature was shaped and re-shaped through family histories and personal memories. The experience made visible how human’s connections with nature are personal, complex, and context-

dependent. Findings provide a baseline for further learning initiatives that take into account how social, cultural, and historical experiences can potentially shape environmental agency.

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