

Educating for relational curiosity and care in place-base science education: A pilot study

Bud Ira Bong

A thesis

Submitted in partial fulfillment of the requires for the degree of

Master of Education

University of Washington

2024

Committee:

Philip L. Bell

Katie H. Taylor

Program Authorized to Offer Degree:

Learning Sciences & Human Development

©Copyright 2024

Bud Ira Bong

University of Washington

Abstract

Educating for relational curiosity and care in place-base science education: A pilot study

Bud Ira Bong

Chair of the Supervisory Committee:

Philip L, Bell

Learning Sciences & Human Development

This design-based research pilot study explores how place-based learning can support and restore reciprocal, caring relations with the natural world through fostering relational habits of mind as people walk through the world together.

This paper necessarily challenges the perception of the sciences as being value neutral, acultural endeavors that explore a shared world. It does this through an interactional analysis of the subjective interpretive steps of learners who have been influenced by Western axiological, ontological, epistemological, ethical, and political commitments. Drawing from Indigenous scholarship and the philosophy of science, I investigate emplaced sensemaking of a triad of graduate students showing how diverse ontologies of land inform the knowledge-making processes and the subsequent futures those knowledges make possible or foreclose. The paper ends with reflections of the

possibilities of how design-based research can help promote relational ways of knowing
and being in the world by developing supportive pedagogies of walking

Introduction:

Science is popularly believed to be a value-neutral means of producing universal knowledge about the world around us. However, this reputation is not exactly deserved, from the hypotheses scientists pose to the answers they settle on, there are numerous interpretive steps guided by the investigator's underlying axiological, ontological, ethical, epistemological and political commitments (Bang 2016, Deloria 1986, Latour 2004, Liboiron 2022). This has led to a situation in which the belief that science is a value-neutral, acultural means of investigation has obscured considerations surrounding the historically Western values in which it has been taught, learned, and conceived. In the paradigm of what I will refer to moving forward as "dominant science", these subjectivities are often sourced in Western ways of knowing and being that view humankind as existing atop a hierarchy of species and as fundamentally different, better than, or separate from the natural world (Bang et al. 2018). This hierarchical human-nature orientation is but one dichotomy perpetuated by the western instantiation of ontological dualism which can be found at the root of contemporary planetary crises such as anthropogenic climate change, the mass extinction of species, and the disproportionate distribution of resources and harm between global north and global south.

The following is a design based research pilot study, a research methodology concerned with designing innovative learning environments that support knowledge development of a prespecified desired learning outcome, and some fundamental theoretical contribution to how learning occurs more broadly (Bell 2004, Brown 1992,

Sandoval 2014). Specifically, this design based research study takes inspiration from Indigenous scholarship, the philosophy of science, and my own lived experience as a non-traditional higher education student and late-comer to the sciences to understand how varying ontologies of land inform knowledge making practices and what/whose futures those practices may or may not favor. It seeks to add to a growing body of literature committed to designing learning environments that engage and embrace onto-epistemic heterogeneity in the learning process, as opposed to treating divergent epistemic orientations as deficient and candidates for assimilation into dominant paradigms (Barajas-López & Bang 2018, Escobar 2018, Marin & Bang 2018). It holds that since science is fundamentally about empirically investigating the natural world, that our relationships with and responsibilities to the interconnected meshwork of life that makes that world possible ought to figure prominently in its practice. Indigenous sciences in particular have long held epistemic commitments to the practice of observing relationships of kinds in order to describe, predict, and generate knowledge regarding the environment, however, the chauvinism of dominant science routinely dismisses these forms of knowledge as lacking “rigor” or possessing some unspecified primitive characteristics that make them unscientific (Cajete 2000, Hird et al. 2023).

Ultimately, the learning environment designed here is meant to further specify how place-based learning can support and restore reciprocal, caring relations with the natural world by prompting participants to see and relate to lands, waters, and more-than-human kinds in deeper ways than what is typical in dominant school-science pedagogy and to then connect those relations with their understandings of the enterprise of the sciences and envisioned futures in critical ways. This work takes

seriously the fundamental role that nature-culture relations play in the knowledge making process. That is to say, what lands, waters, and more-than-human kinds mean to us culturally are reflected in the way we teach, imagine, know, study and make meaning in concert with the natural world and if we are to begin repairing the harms of modernity we must focus on healing our relationships with place (Bang & Marin 2015). To that end, this work leverages a place-based pedagogy of walking located at an urban nature space in which participants are introduced to varying models of land relations (Kimmerer, 2013) and the role that grammar choices play in shaping those relations including the subsequent visions of science and the futures they support (Bang 2015, Marin 2020). In sum, this intervention strives to make just and sustainable change in science education by engaging across the disciplinary fields of the social and life sciences to co-construct new narratives and possibilities through remade relations with the natural world (Bang et al. 2016).

Literature Review:

Critiques regarding the intersection of science, power, and values are not uncommon. Throughout the history of science socio-cultural theorists across disciplines have sought to make evident the ways in which social, political, and economic interests have made use of science to ideologically name the world and legitimize practices of domination. From the notion of theory-laden perception (Goldenberg 2006, Kuhn 1996, Feyerabend 1978) which argues all observations are essentially stained by our background beliefs and assumptions to the feminist theory of the unconditioned subject which challenges the notion that a given investigator can possibly be a detached,

neutral, unconditioned epistemic agent—values clearly inform the knowledge making, and therefore world-making, process (Goldenberg 2006, Longino 1993).

In “Moving beyond ontological (worldview) supremacy: Indigenous insights and a recovery guide for settler-colonial scientists”, Coen Hird and associates call for scientists to make explicit their own positionality in their research as the pursuit of “objectivity” in science often leads investigators to ignore the social and political contexts of their research which provides the foundation for their epistemological assumptions (Hird et al, 2023). Escobar (2020) illustrates the problems with objectivity and science nicely:

The conventional scientific approach instills in us a cosmivision that divides the world into subjects and objects, a world we can understand and manipulate at will. This objectivising operation is a main pillar of modern Western civilization (with its patriarchy, racism, coloniality, and capitalist exploitation); it is at the basis of the separation between subject and object, reason and emotion, human and non-human, and many other dualisms. (Escobar, 2020, pg. 30)

In offering this critique, Escobar is alluding to a need for the ways in which we as scientists, researchers, humans design our ways of life (education, transportation, architecture—everything) to resist the ontological dualism they describe above and reach for relationality: the presupposition that life is not lived under conditions of separation but of radical interdependence of everything that exists.

This human-nature dichotomy and anthropocentrism is a hierarchical dualism deeply embedded in notions of progress and modernity that Indigenous peoples across the globe have been resisting and designing against in different forms since first contact. Doing just this is Marin and Bang's 2018 work "Look it, This is how you know: Family Forest Walks as a Context for Knowledge-Building About the Natural World." in which the joint-activity of Native American families situated in place gives rise to knowing the natural world. In doing so, Marin and Bang make use of a theoretical and methodological blend involving sociocultural theory, interaction analysis, mobilities and place, and Indigenous epistemologies to analyze how the more-than-human world acts as a semiotic resource that shapes the relational, conceptual and epistemic processes of human sense-making on familial nature walks. At the core of this work is the position that "...advancing foundational knowledge about human learning and development requires that researchers work to see cultural variations in ways of knowing and being" (Marin & Bang, 2018, p. 90), offering that one way to do this is to push beyond the lens of anthropocentrism as the primary context underlying the research questions and agendas we pursue. As such, Marin & Bang argue that "reading and storying land" involves a coordination of attention between human and more-than-human interlocutors when identifying and naming "natural kinds, finding evidence, and generating explanations to create a story about the perceptual field"(Marin & Bang, 2018 p.90). Marin & Bang come to term this method a "Pedagogy of Walking" interested in the affordances of walking for learning about the natural world, developing relationships with land, and envisioning possible socio-ecological futures. Ultimately, the authors conclude that walking, reading, and storying land combine to be an assemblage of

practices that shape cognitive development in the way that people work to understand and story their positions within and responsibilities to lands, waters, and the more-than-human world.

As will be discussed in greater detail later, Marin & Bang's work provides strong inspiration for this project as it calls for: (a) embracing cultural variations in knowing as a means towards more expansive/inclusive notions of science, (b) Includes notes of animism in the way one sees and interacts with place to destabilize anthropocentrism and finally, (c.) the value of movement and sensory engagement in learning about and developing relationships with lands, waters, and more-than-human beings.

Additionally, Dr. Marin's 2020 article "Ambulatory Sequences: Ecologies of Learning by Attending and Observing on the Move" provides further depth to this project's design as well as the chosen analytic unit—ambulatory sequences. In describing the ways in which dominant/colonial values have historically functioned to "other" people and place, Marin demonstrates how Western anthropocentric ontological commitments relegate non-dominant communities, including more-than-human communities, to the designation of objects and property to be leveraged for social, economic, and political gain. These considerations regarding the power and historicity of place, Marin argues, serves to bring "...the past into the present in ways that support re-making relations as well as imagining and experiencing possible futures" (p. 283). This integration of space and time in the ways in which one navigates the world from highly designed human environments to "natural" spaces provides strong support for a need to better understand embodied, place-based, and mobile perspectives in research. This leads to the description of "ambulatory turns" as a relational unit of analysis in

which one's feet/body literally meet (come into relation with) the earth. As one shifts between continuous movement through place and as they come to pause and dwell in place, various semiotic resources are engaged in ways that fundamentally shape and inform the meaning-making process and affective states of the participants.

Taken together, this design-based research study combines mobility (walking), place (an urban nature preserve), and design artifacts (to be introduced below) hypothesized to support expanded views of science and increased senses of socio-ecological care by supporting the development of relational habits of mind amongst its participants.

Methods with Conceptual Commitments:

Recall, the impetus for this work is the constant, looming threat of social and ecological collapse on a planetary scale, of which the Eurocentric world making process is largely responsible for. It is a learning design meant to support participants to be critically aware of the dominant axiological and ontological commitments underlying their enculturated worldviews, how they show up in epistemic practice, and what futures those practices make possible or preclude. As this work engages across the disciplinary fields of the social and life sciences to co-construct new narratives and possibilities through remade relations with the natural world, It takes particular aim at stirring critical thought regarding how Western nature-culture orientations (ontologies of land) and dominant scientific reasoning co-construct Eurocentric futurity in an effort to support expanded views of science, greater socio-ecological caring identities, and associated relational habits of mind amongst it's participants.

Underlying this design process is a methodological blend shown by scholars with similar research commitments to yield promising results in fostering or promoting onto-epistemic heterogeneity in many of the same ways that this research is committed to doing (Marin & Bang, 2018; McDaid Barry et al., 2023; Pugh et al., 2018). These methods include cultural historical activity theory (Engestrom, 2011), interaction analysis (Derry et al. 2010, Goffman 1983), mobility and place (Marin 2020), and Indigenous epistemologies (Marin & Bang, 2018; McDaid Barry, 2023) brought together in the interest of answering the research question: How can collaborative, place-based learning regarding various models of land relations support expanded views of the sciences, greater socio-ecological caring identities, and relational habits of mind among college-aged, science-interested participants.

At the core of this design is the concept of place. Often misunderstood, place in this context deals in space, time, power, historicity, and knowledge in a way that is often overlooked, or purposefully left absent, in dominant research paradigms. As scholar and geographer Doreen Massey defines it, place encompasses more than physical locations, it is a crossroads of happenings and histories, or a "...collection of stories [and] articulations within the wider power-geometries of space" and to travel from place to place is to "...move between collections of [these] trajectories and to reinsert yourself in ones to which you relate...places not as points or areas on maps, but as integrations of space and time; as spatio-temporal events" (Massey, 2006). That is, place functions as more than a mere surface for immediate human activity; It is a multiplicity, a convergence of stories, space, and time that shape the very nature of our interactions and how meaning is dynamically and collaboratively made from them. Place in this

research context is invaluable as it allows for finer attention to be paid to the ways in which power dynamics are imbued within place, how they shape the ways in which lands, waters, more-than-human kinds are viewed, environmental issues broadly construed, and how they intersect with social and political issues as participants negotiate the sense-making process in real time. This is all to say, addressing the greatest problems of our time is not strictly a matter of scientific and technological innovation, nor will they be relieved solely by social and political reform. A broad societal shift in the ways people relate to place is needed, including learning environments designed to support and foster shifts towards relational onto-epistemologies of lands, waters, and more-than-humans, like this one.

The concept of place partners nicely with this work's interest in expanding on the affordances of walking (or mobility broadly construed) for learning about the natural world, developing relationships with lands, waters, and more-than-human kinds, and envisioning possible socio-ecological futures (Marin & Bang 2018, Barajas-López 2018). As developed by Marin & Bang and expanded on by numerous studies since; the process of walking, reading, and storying land involves a coordination of attention between human and more-than-human interlocutors when identifying and naming natural kinds. Crucially, this pairing of mobility with place encompasses the perspective that the land itself, including its ever-changing state, is a relevant semiotic field constitutive of the meaning-making process. The anticipated shifts in participants axiological and ontological understandings of the world that this work has been designed to facilitate are tracked via the method of interaction analysis (Derry et al. 2010, Goffman 1983, Erickson 2004) which allows for fine-grained attention to be paid

not only to the storying occurring amongst the participants but also to the phenomena (i.e. lands, waters, more-than-human kinds) that enter and exit the perceptual field as the contours of land shape movement, attention, experience, and the subsequent meaning negotiated and derived from what/who is present and observable (Marin & Bang 2018).

Additionally, the practice of spatial indexing is tracked as it figures prominently in the practice of reading and storying land as it is characteristic of the process of noticing phenomena in the spatial field while connecting it to something else spatially, temporally, and/or relationally (Pugh et al., 2018). In the interaction episodes I share below, this geo-semiotic practice of spatial indexing will be leveraged to mark and analyze participants puzzling around land, more-than-human relations, and Western taxonomies of kinds.

Given that the overarching goal of this research is to further our comprehension of the role anthropocentrism, nature-culture orientations, and understandings of place play in the knowledge making process Ananda Marin's relational unit of analysis: ambulatory sequences is used to parse the data. In short, ambulatory sequences highlight the ways in which situated activity systems emerge from configurations of movement, helping identify who/what is being attended to and why, and how knowing is negotiated amongst a group. Ultimately, ambulatory sequences provide a powerful way to attend to place as it helps the researcher see a collection of "Stories-so-far" in relation to lands and waters as they are shared amongst participants as they walk and story land. Indeed, the practice of spatial indexing (Pugh et al, 2018) is found in many cases to mark the beginning of ambulatory turns. From the cultural historical activity

theory (CHAT) perspective ambulatory sequences and the practice of spatial indexing allow for understanding just how participants interact and navigate their social and natural realities as mobility, place, and design artifacts combine to support shifts in participants ontologies of land.

Study Design:

The data presented comes from a pilot study surrounding the intersection of science, place, and care conducted in Seattle, Washington's Discovery Park in the Spring of 2023. It is the product of a conjecture mapping practice which outlines a systematic approach to educational design research in which a high level conjecture is offered, embodied practices and mediating processes are proposed, and possible outcomes are posited (Sandoval, 2014) (see figure 1.1). The participants were 3 college-aged graduate students with expressed interests in environmental protection/education, Indigenous ways of knowing and being, and working towards just multispecies futures. At the trailhead of Wolf Tree Trail participants were equipped with head-mounted go-pro cameras while the researcher positioned themselves to hold a camera capturing the other two in third-person. Participants were then introduced to the overarching purpose of the study summarized as an effort to more fully understand how learning in place (remediating nature-culture orientations) can support expanded visions of science, deeper socio-ecological caring identities, and relational habits of mind—the intersection of science, place, and care.

Participants were told that the purpose of this study was to examine how, when framed properly, lands, waters, and the more-than-human world can support expanded views of science and greater senses of ecological caring. This pilot was designed to

have three segments where participation structures, artifacts, or discursive practices would be introduced. The first would be at the trailhead, the second 10 minutes into the walk, and the third 20 minutes into the walk. At the trailhead, participants were given a field notes handout detailing Models of Land Relations (See figure 1.2) adapted from Robin Wall Kimmerer's seminal work *Braiding Sweetgrass* (2013) and asked to look for evidence of any of these kinds of relationships and discuss as they walked the urban nature space (Bell, 2024). After 2 self-selected ambulatory turns (roughly the 10 minute mark) they were introduced to a diagram of ego vs. eco -centric nature-culture orientations designed by Steffen Lehmann (See figure 1.3) as well as the concept of Robin Wall Kimmerer's grammar of animacy and asked to do their best to adopt more relational language choices replacing subject-object language like "it" and "thing" with animating pronouns of their choice at their discretion. Finally, at the 20 minute mark they were introduced to a series of diverse intelligence cases offered with the intention of confusing popular notions of human intellectual and moral supremacy. These were selected in order to support participants to think critically about how extractive, violent, and de-futuring relationships enacted by humankind on natural kinds are implicit in the very ways we see, speak of, and reason about lands, waters, and more-than-human kinds. Taken together, this experience is hypothesized to support expanded visions of science, greater socio-ecological caring identities, and relational habits of mind in participants via stirring critical thought surrounding the axiological, ontological, and epistemological commitments lying unassumed at the foundation of their worldviews.

Figure 1.1 Conjecture Mapping

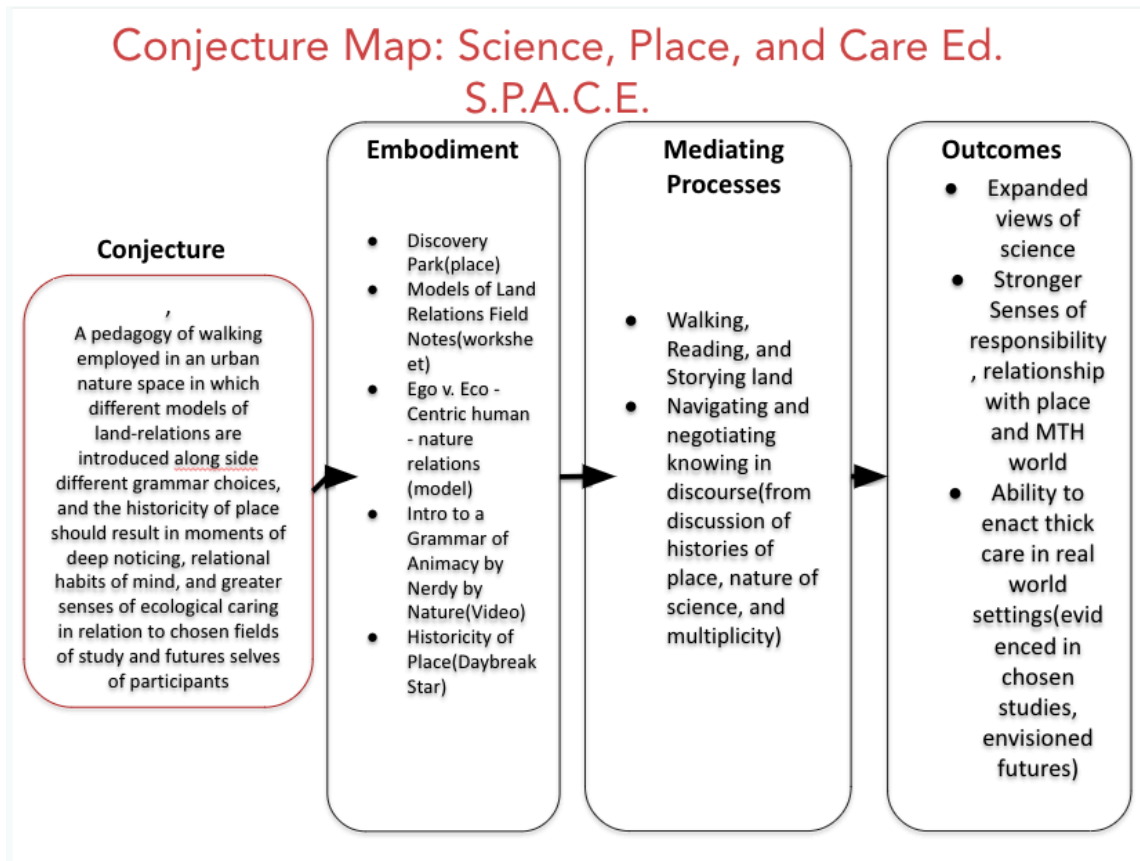


Figure 1.2 Models of Land Relations Field Notes (Bell, 2024 based on Kimmerer, 2013)

Models of Land Field Walk

Model of Land Relation	What supporting evidence can you identify for this model in this place?	What supporting evidence or stories could exist for this model in this place if we imagine an ethical, possible future?
1. LAND AS CAPITAL: viewing lands only as a means to make money by extracting resources		
2. LAND AS PROPERTY: viewing lands as private property, a mine of "resources"		
3. LAND AS MACHINE: e.g., utilizing plants as an engineering solution to pollution		

Take a walk in a small group noting evidence / clues for different models of land relation. Take a pen. Be sure to inquire with each of the models over time.

4. LAND AS TEACHER / HEALER: "The beds are greening over. The land knows what to do when we do not... The very best scientists are humble enough to listen."		
5. LAND AS RESPONSIBILITY: creating habitat for nonhuman relatives; engaging in biocultural / reciprocal restoration		
6. LAND AS SACRED, LAND AS COMMUNITY: celebrating lands and waters, renewal of the covenant between people and the lands & waters		
7. LAND AS HOME, LAND AS SELF: people living in balance with the land, in deep relation to the land		


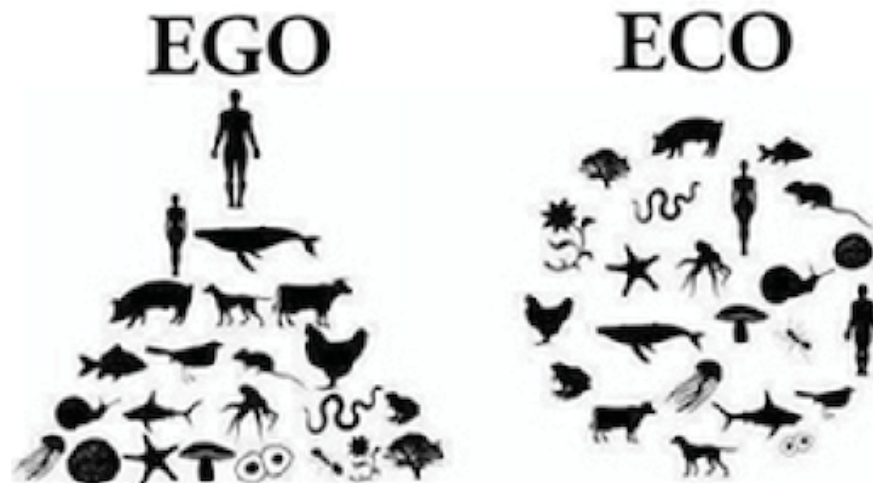


Figure 1.3 Lehman's Ego vs. Eco-centric model of human belonging



Analytic Approach:

In conducting analysis for this project I engaged in an inductive approach to video data analysis, viewing the data multiple times, including several lab based viewings with graduate students from the University of Washington interested in the method of interaction analysis (Derry, 2010). While Marin's ambulatory sequences as a method and unit of analysis was on my mind when designing this pilot study, I did not explicitly attempt to design for ambulatory sequences. Only after repeated viewings was Marin's ambulatory sequences as a method and unit of analysis settled on as it became clear that it offered discrete, recognizable courses of action that support the analysis of relationships between participants movement, attention, and observation as they collectively imagined, negotiated, and enacted different possibilities connected to shifting ontologies of land.

This process involved segmenting the data around ambulatory turns, or when at least one participant terminated their movement and came to dwell in place for a minimum of 6 seconds. Upon identifying six ambulatory turns I categorized them by the natural kind that facilitated the pause in mobility (Skunk Cabbage, Creek Bed, Hazel, Cedar, Stump, and Log) and color-coded them based on what phase of the walk they occurred in. In this case, the six ambulatory turns were formed equally across the 3 interventions; Skunk cabbage and Creek Bed occurred during the introduction and models of land relation portion of the walk, Hazel and Cedar occurred during the Ego vs. Eco and Grammar of Animacy portion, and Stump and Log occurred during the closing diversifying intelligence considerations portion of the walk. I then developed content logs of each ambulatory turn, paying special attention to question, answer, and

evidence-offering sequences as initially described by Schegloff (1972) and later leveraged by Marin and Bang (2018) to identify and evaluate episodes of epistemological navigation. Upon doing so a theme regarding the role of naming and knowing natural kinds emerged in which participants became concerned with how knowing practices can support or hinder relationality. These micro-storying practices occurring across ambulatory turns were then used to identify the ambulatory sequence, how microstorying practices and epistemic ecologies form and shift across numerous turns concerning a focal interest that persists across several ambulatory turns. In the following section of this paper I will elaborate on how place, mobility, and designed artifacts afforded the formation of a semiotic substrate, or confluence of otherwise disparate forms of symbolic communication, that supported participants in reaching for more relational ontologies of self and land through indexing practices, expressions of curiosity and critique, and the subsequent realization of possibilities that stemmed from them.

Findings:

Below is a step-by-step analysis of the focal ambulatory sequence of this paper. It consists of four ambulatory turns in which spatial indexing practices lead to expressions of curiosity, expressions of curiosity lead to moments of critique, and moments of critique lead participants to query the intersection of ontologies of land, knowledge production, and possible futures. As this process plays out across human and more-than-human meaning making practices, I conclude by leveraging the concept of a semiotic substrate as an analytically comprehensible theory contribution in educating for relational curiosity and care in place-based science education.

Indexing and Curiosity

The following transcript is of the first ambulatory turn in this sequence and falls within the first portion of the walk, at this stage participants have experienced only an instructional launch surrounding the intersection of nature-culture orientations with scientific thinking and what/whose futurity those knowledge practices privilege as well as the previously described Models of Land Relations field notes handout.

The first ambulatory turn in this sequence begins with the noticing of an unknown plant, of which the size of its foliage causes some excitement amongst the participants.

Ambulatory Turn 1 - Skunk Cabbage: Storying and the Epistemic Ecology(Curiosity)

1. J: Gosh look how big those leaves are though!! (Index)
 [Movement Halts]
2. M: Which ones? OH!
3. J: ((points))
4. M: What is that??
5. J: I have no idea..
6. M: It looks...prehistoric **{See figure 1.4}**
7. J: That looks like skunk cabbage but like..twisted...like on steroids.
8. M: yea..

[Movement Resumes]

Figure 1.4 Talk Turn 6: “It looks...prehistoric”



Here, the physical positioning of participants as shaped by the contours of land combined with verbal and embodied engagement come together to form an epistemic ecology. As Melander (2012) describes, epistemic ecologies are formed by the spatial organization of humans when orienting to, sharing in, and negotiating the knowledge making process. Adding to this, Marin (2020) sought an understanding of epistemic ecologies beyond the typically assumed anthropocentric stance to include and attend to how knowledge is called forth by more-than-human forms of life and what that means to the knowledge making process. While this interaction appears relatively minor it functions to open a space of curiosity, setting the stage for subsequent storying regarding skunk cabbage and the practice of naming and knowing natural kinds.

As movement resumes, participants are stopped by a flowing creek. Conversation forms around the dynamic nature of water, the shape of the creek, and the sounds the creek is making. The following transcript picks up as B, engaging in the

practice of spatial indexing (Pugh, 2018), recognizes a plant in the creekbed as being similar to the one that previously stopped the group [Turn 9, below]. Here participants resume the practice of reading and storying land as they coordinate attention and observation with the purpose of identifying and naming a natural kind.

Ambulatory Turn 2 - Creekbed: Storying & Setting a Semiotic Substrate (Critique)

9. B: Is that the same plant as before?(Index)
10. J: these just look...like too big
11. B: Yea, the skunk cabbage that I have seen do not uh
12. M: ((pulls out phone and aims toward plant))
13. B: get that big but I also understand that (.) some flora le-they
produce larger leaves depending on how much sun they get, so the
less sun they get the larger the leaves are so t-they can get more
bang for the buck, where if they're in direct sunlight they'll produce
smaller leaves
14. J: I dunno, that's within reason
15. B: yea...
16. J: like there's a limit to how big the leaves wil[get]
17. B: [right]
18. M: ((Holds up phone)) it says that I[t is skunk cabbage] **{See Figure 1.5}**
19. B: Ohh you[have that, woo]ow..wha-what is that?
20. M: It's called seek by iNaturalist

21. B: 'cause that's something I'm really interested in. Um..one of the things..uh..On the whole Robin Wall Kimerrer space here((circling hand gesture)) She gave a talk a few weeks ago, were you there?(3) One of the things she brought up was young people can name a thousand brand names just off recognition of the logo(1)[(creek babbles] but walking down the street they can't name more than 10 of like..the plants in the area.

22. J: uh-hunh like the plant species((bends down and picks a plant))

23. B: which like naming is part of like the respect or what kind of relationship you have with the world around you. So I was thinking about how that app works to help ME to be able to name more things, but also, how technology can act to facilitate relations with earth, as opposed to popularly conceived as like deepening a kind of divide

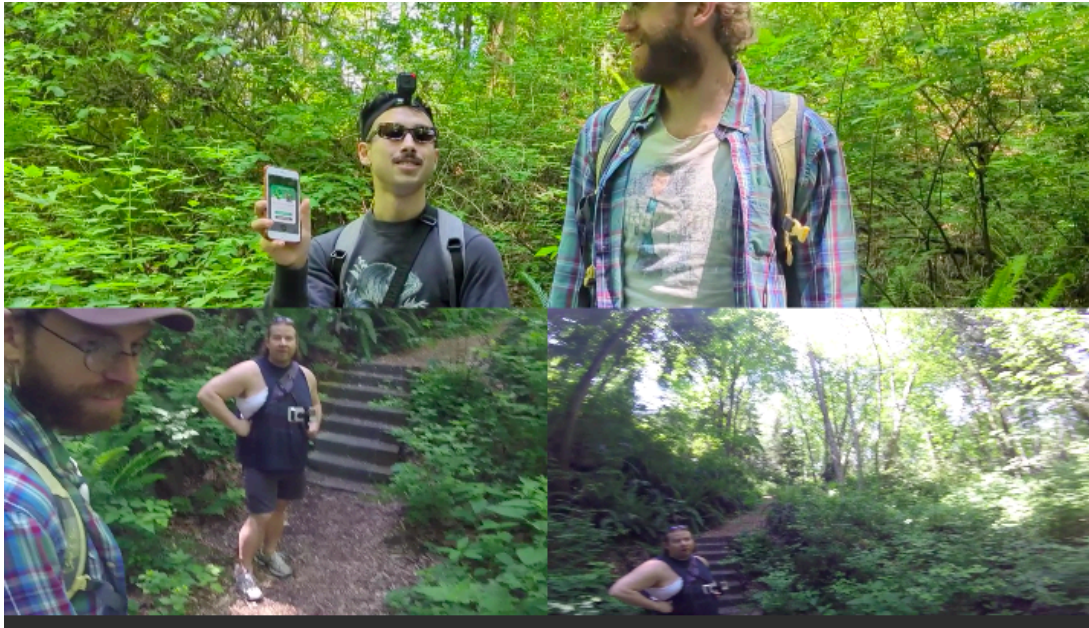
24. J: Which..like, I-i think there is like a lot of value in Seek and what it can provide but I think sometimes naming a thing kind of like ((snaps fingers)) ends the relationship right there

25. B: yes

26. J: It's like as soon as you know the name, great! Now I know the name and often a lot of these apps kinda don't provide the like..ecological context for the species and like how it relates to other things..but and that's not what I'm saying you're doing ((gestures to Martin))

27. M: Yeah.

Figure 1.5 Talk Turn 18: “It says that it’s Skunk Cabbage”



Curiosity and Critique

In this ambulatory turn, B’s indexing practice draws upon past experiences with Skunk Cabbage, both temporally close and distant, in conjunction with an offering of biological reasoning to explain the large foliage size [Turn 13]. By introducing this biological reasoning, the leveraging of principles and concepts as described by the biological sciences, to the storying of Skunk Cabbage, B introduces a dominant form of scientific reasoning when connecting leaf size and photosynthesis to the epistemic ecology that comes with both affordances and constraints. This dominant mode of reasoning is then compounded as M leverages technology to “officially” identify and name the plant as “Skunk Cabbage” (See image 1.5). Recalling that Marin’s development of ambulatory sequences was, in part, motivated to understand how knowledge is called forth by more-than-humans, up to this point participants have

engaged in a largely anthropocentric epistemic ecology, leveraging science and technology to reason about and describe the field (Marin, 2020). However, a moment of critique offered by J shifts the dynamic of the ecology to a more relational kind [Turns 24-26]. In response to B's move to frame the technologically assisted naming practice as a reach for relationality and a possible tool in re-mediating (Gutierrez et al. 2009) relations with the natural world, J reasons otherwise, offering that naming alone does not necessarily make for a consequential and relational interpretation of knowing. This critique and call for relationality serves to shift the epistemic ecology and becomes a platform for understanding the intersection of science, place, and care moving forward on the walk.

This interaction regarding naming and the need for a deeper, more relational, practice of knowing ends up serving as a focal point akin to Charles Goodwin's (2018) notion of a dialogic substrate for the remainder of the walk. According to Goodwin a dialogic substrate is a kind of co-operative, conceptual workspace that serves as a platform for current and subsequent meaning-making practices to take place. Given the fundamental role that natural-kinds, contours of land, and design artifacts play in shaping the epistemic ecologies throughout this walk, I choose not to use the human-language centered notion inferred by the term "dialogic", instead, I have been using the term semiotic when referencing this substrate as it captures a more holistic and equitable picture of how the meaning-making process is distributed across environment, the life-world, tools, and artifacts. That said, participants will repurpose, depart from, return to, and negotiate meaning from this semiotic substrate regarding a

need for context-driven, relational forms of complex socio-ecological reasoning throughout the rest of this walk.

Zooming out briefly, the interaction episodes that led to the establishment of this semiotic substrate and the ways it will be returned to and repurposed throughout the remainder of this sequence I connect to one of the core outcomes this work is designed to facilitate—Care. Care, as defined in the living lexicon of environmental humanities, is a profound affective, ethical and practical engagement with the world and requires becoming subject to an “unsettling obligation of curiosity” (van Dooren, 2014). Author Thom van Dooren, in synthesizing Maria Puig de la Bellacasa (2012) and Donna Haraway’s (2003) feminist ethics of care works, offers us a potential to understand care itself as a vital practice of critique, a curiosity that opens up an appreciation of historical contingency; that things might have been and so might yet still be otherwise.

Here, in connection to care and how it provides a foundation for hope, and futurity, I take the “unsettling” obligation of curiosity both literally and figuratively in that the critiques made about dominant (settler) nature-culture orientations in the above and following socio-ecological reasoning is, at its core, a critique of anthropocentrism and the ways it has explicitly and implicitly functioned as a cornerstone of the Western worlding process. Indeed, Bang et al. broach this topic in their 2013 work “Desettling Expectations in Science Education” arguing that context-independent classifications regarding the intrinsic attributes of things make unspeakable the ways in which nature and culture are intertwined. The participants in this study can be seen as likely navigating their enculturated “school-science” understandings of the natural world with more complex, relational, contemporary, and plural visions of science and the natural

world. In line with van Dooren's explanation of care, we see critique resulting in possibility, in this case a reach for more contextualized and relational approaches to knowing and naming allows participants to question and remake long-held notions of the real and the possible, multiplying the real, and expanding the fields of the possible (Escobar 2017, Harraway 2015, Puig de la Bellacasa 2003).

Critique and Possibility

Hereon I will expand on the above argument that this learning-in-place design, ambulatory turns, and chain of storying practices from (*Indexing* → *curiosity* → *critique* → *possibility*) combine as a course of recognizable actions that constitute an emergent form of care.

Following the end of Ambulatory turn 2 was the addition of two supporting artifacts meant to support participants in stirring their ontologies of land. These included Steffen Lehman's Ego Vs. Eco -centric models of human belonging [Image 1.3] and an introduction to Robin Wall Kimmerer's conceptualization of a grammar of animacy. In the below transcript we join the participants playfully leveraging a grammar of animacy to anthropomorphize the world around them¹ resulting in some perspective taking, shifting between human and more-than-human perspectives, and eventually an uptake of the established semiotic substrate.

Ambulatory Turn 3 - Hazel: Animated Perspectives (Possibility)

¹ Here I would like to acknowledge that anthropomorphizing natural kinds is not the goal of a grammar of animacy and can result in problematic anthropocentric reasoning. It is included here because it leads to an uptake of the established dialogic substrate regarding context and relationality.

28. J: Okay well first thing ((walks to plant and rubs leaf)) Girrrl why are you so soft? ((Facing B)) you should come feel this. (Index)
29. B: mmm..wow that is...really soft hehehe, surprise!
30. M: Why do you think...
31. J: I have no idea ((Leans in))
32. J: But yea...she is hazelnut, squirrels love her.
33. M: mm ((nods))
34. J: Yea it's hard for us to get any hazelnuts because the squirrels are so quick! And they often get things before they are ripe and ready for us to eat. I wonder if they taste good to the squirrels at that stage or if they're just like "I'm hungry!"
35. M: Squirrels I feel like are so gluttonous...or is it greed? Greed is um...like ((gathering gestures with hand)) like retention y'know? And for squirrels, maybe it's both because they like just bury their nuts..
36. J: I think that yea...well they're doing an important eco-system service in doing that because a lot of oak t...acorns...wait no, are acorns from oaks? Yea..a lot of acorns that are buried by squirrels turn into oak trees...that is a mutualistic relationship between oak trees and squirrels

On the heels of being introduced to a grammar of animacy anthropomorphic practices (Turns 28-32) mingle with some shifting between human and squirrel perspectives (Turn 34), ultimately resulting in a return to the established semiotic

substrate. When J offers ecological context regarding squirrels nut caching behavior (turn 36), he describes it as a mutualistic relationship, this can be seen as in service to the established semiotic substrate as he returns to a previously established theme where knowing in meaningful ways was agreed to require relational context. This repurposing of the substrate continues in the following final exchange as the demand for relational ecological context in coming to know the natural world is pushed from ecological context in relation to human interests (i.e. greedy squirrels getting the nuts before humans can), concludes in a repurposing of the semiotic substrate that questions human-kinds ecological belonging.

Ambulatory Turn 4 - Cedar: Relational Querying (Possibility)

37. J: ((presses hands against tree)) haha some tree's could be greedy ((turns and points to another tree)) like maple, maple's branches go so far out ((spreads arms out)) and are like "I'm gonna take all the sun" ((Claps hands)) but...there's also a lot of shade tolerant trees...

38. M&B: yea ((nodding))

39. J: heh I mean...((Sigh)) i like the idea of us putting these characteristics on them ((laughing)) cause literally everybody is doing what they're supposed to do because what they're supposed to do is what they're doing.

40. M: heh yea..yea

41. J: Even if there is a creature that is "invasive" like they're still doing what they're supposed to do

42. M: invasive...species((looks up and down))

43. J: But are we doing what we are supposed to be doing?

Recall, the establishment of this group's semiotic substrate arose from a critique of naming practices that resulted in a demand for ecological context and more relational processes of coming to know. Earlier, I argued that this was, at its core, a critique of anthropocentrism as up until that point participants had engaged in predominantly Western onto-epistemic deliberation. Through the establishment of a relational semiotic substrate the epistemic ecology shifted, making the obligation to know more about the world emerge as a kind of demand for deeper contextual and relational knowledge regarding the foci of our care - in this case the lands, waters, and more-than-human community of the Wolf Tree Trail. This push for relationality allowed for the indexing of natural kinds to draw forth direct experiences from the participants that shifted the sense-making process to a more relational form. As participants continued to move and encounter different more-than-human kinds, their reasoning led them to question their very own ecological context, role in the natural world, and belonging which I argue is the greatest kind of possibility. One that begins to transform a life's worth of ontological dualism and one-world conditioning to place oneself at stake in the world by recognizing oneself as part of a meshwork of interrelations.

Discussion:

Thus far I have made the argument that in order to address the greatest issues of our time, the Western value systems underlying our knowledge making processes must be made to evolve. This design based research pilot study has attempted to do just that

by supporting shifts in participants ontological commitments regarding the intersection of land relations, knowledge production, and possible futures through place-based science learning. In doing so, the land itself, including waters and more-than-human kinds, in concert with mobility and the artifacts designed to foster critical thought regarding nature-culture relations resulted in participants placing themselves at stake in the world. This is evidenced in ambulatory turn 4 (AT4), talk turns 39-43 when talk regarding roles in the more-than-human community of the Wolf Tree Trail leads participants to question their own role/belonging in the ecosystem. Affording this arrival to relational querying was what I have been referring to as a semiotic substrate (index → curiosity → critique → possibility). In the following I will describe how this semiotic substrate and relational querying was made possible by the design elements of this study.

Beginning with the practice of spatial indexing and the process of reading and storying land, Anthropologist Eduardo Kohn's 2013 work "How forests think: Toward an anthropology beyond the human." argued that multispecies relations are not only possible, but analytically comprehensible thanks to their shared semiotic propensities. Pugh et al. followed in 2018 with their work on developing relational epistemologies in land-based learning environments finding the practice of spatial indexing to be a critical element in the process of reading and storying land as it allowed for the field of social semiotics to encompass the natural semiotic world. That is to say, in recognizing lands, waters, and more-than-human kinds as active and relevant semiotic agents, or even social actors in their own right, a more complete understanding of relational, conceptual, and epistemic practices of land and place-based learning can be achieved.

Throughout this study, I found the practice of spatial indexing to regularly precede the beginning of an ambulatory turn. As participants came to pause and dwell in place, the practice of spatial indexing often led participants to the second step of the semiotic substrate: curiosity.

Expanding on the role of curiosity in this semiotic substrate I refer back to the demand for care requiring an “unsettling obligation” of curiosity. Curiosity is intrinsically tied to knowing in that it guides the kinds of wonderings, noticings, questions and problems one lends credence to. In this case, the artifacts and interventions made use of in this study were designed to foster a critical form of curiosity regarding ontologies of land, knowledge making, and possible futures. The field notes handout on Models of Land Relations was designed to help people actively “see” how differing ontologies of land are made manifest as they navigate from highly designed urban environments to “natural” spaces. Lehman’s Ego vs. Eco -centric model of human-nature relations was introduced to stir critical thought regarding human-kind's place in the natural world. And, lastly, the grammar of animacy was introduced to help people recognize not only the power animated language choices have in how we relate to the world, but how pervasive objectifying language can be and how it forces our curiosity to divide the world into subjects and objects.

We see the influence of these artifacts displayed in the evolution of participants' expressed curiosity communicated from ambulatory turn to ambulatory turn. In the first portion of the walk with only the Models of Land Relations field notes introduced we find curiosity expressed regarding the name of a natural kind in both AT1 and AT2:

AT1, Talk turn 4 M: What is that??

AT2, Talk turn 9 B: Is that the same plant as before?

Leading to an answer:

AT2, Talk turn 18 M: ((Holds up phone)) it says that it is skunk cabbage.

Here curiosity is mediated by technology resulting in a more-than-human kind being identified and referred to as an objectified “it”. However, as more artifacts are introduced in the second portion of the walk including Lehman’s Ego vs. Eco model and a grammar of animacy and as the semiotic substrate begins to take a more solid form, curiosity is expressed differently:

AT3, Talk turn 28 J: “...Girrrl why are you so soft?”

AT3, Talk turn 34 J: “I wonder if they taste good to the squirrels...?”

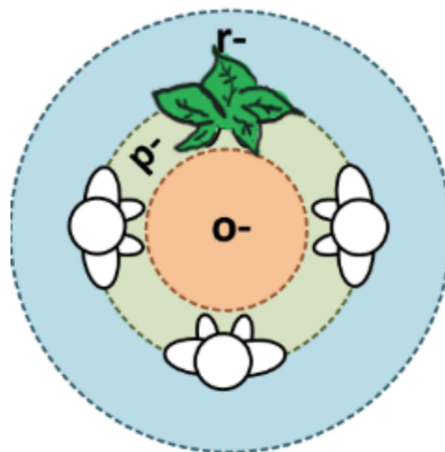
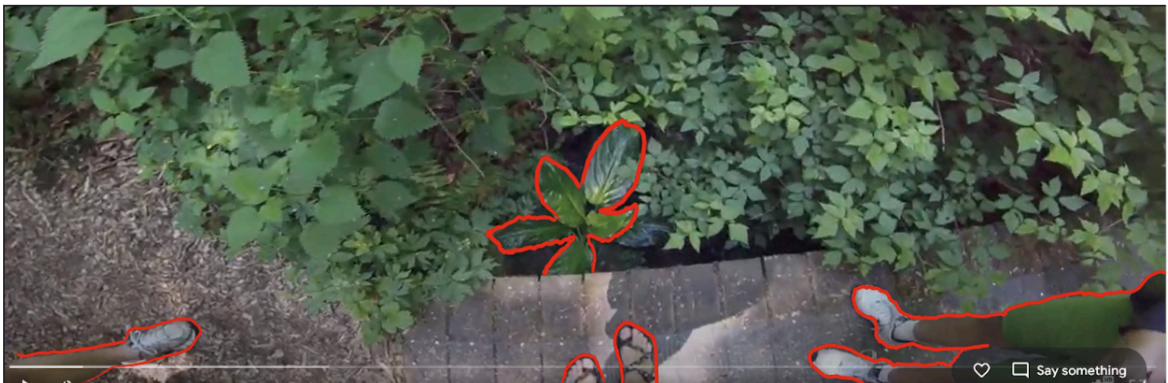
AT4, Talk turn 43 J: “But are we doing what we are supposed to be doing?”

Here we find the kinds of curiosity being expressed to be of a more affective and relational kind. That is, as place, artifacts, and discourse evolve together so too does curiosity, a kind of critique in its own right.

Beyond the aforementioned central role that critique played in establishing the semiotic substrate, I now turn to the constitutive role that land played in motivating said critique. Marin (2020), in discussing the ways in which spatial orientational arrangement in relation to one another and lands and waters, makes reference to Adam Kendon’s (2010) facing formations, or f-formations, in which the formation a group of interlocutors takes serves as a means of maintaining separate identities of participants and the integrity of a given interactional episode as meaning is negotiated and co-constructed

amongst the group. This includes a p-space where participants orient their bodies to create a joint transactional space known as the o-space, in which knowledge is publicly distributed and negotiated in different ways. Vitally, this o-space is maintained by the physical positioning of participant bodies occupying the p-space and can take a variety of forms. Harkening back to this project's commitment to understanding how more-than-human kinds draw forth knowledge that fundamentally informs the epistemic ecology, I turn attention to the spatial orientation occurring in AT2 that gave rise to a vital moment of critique and the establishment of our relationally concerned semiotic substrate.

Figure 1.6: Skunk Cabbage, f-formation



In figure 1.6 we find that the contours of land, a product of learning in place, allows for skunk cabbage to serve as a discussant, occupying a position in the p-space. Here we see spatial indexing and natural semiotics result in the establishment of joint attention with skunk cabbage enabling a kind of attunement and collaborative meaning making process to form. It is my position that this spatial orientation allows for joint attention with skunk cabbage to take a subject-subject form as opposed to a subject-object form and that this positioning is instrumental in establishing the relational focus of the semiotic substrate throughout the rest of this walk.

Implications:

The expected contribution of this study was an increased understanding of how mobility, place, and Indigenous methodologies can combine to support the development of relational habits of mind. This took the form of a design-based research study meant to foster critical thought regarding the role land relations play in the knowledge making process and what/whose futures those practices make possible and preclude. Together place (lands, waters, more-than-humans), mobility (walking), and design artifacts (field notes, Ego v. Eco, Grammar of Animacy) afforded the formation of a semiotic substrate concerned with relationality. This semiotic substrate (index → curiosity → critique → possibility) is an analytically comprehensible theory contribution in educating for relational curiosity and care in place-based science education as it offers a coherent way of understanding the many at large factors comprising a place-based epistemic ecology. Importantly, this makes visible an expanded notion of the social that encompasses lands, waters, more-than-human kinds as active participants in the meaning-making process that is distributed across environment, tools, and the

life-world. Ultimately, these findings stand to challenge dominant paradigms by evidencing how remaking relationships with the natural world through place-based science education is possible - an urgently needed shift if we, as a species, are to address the looming planetary crises exacerbated by Western instantiated ontological dualism.

I will conclude this paper by addressing limitations and future considerations. A key feature of the Design-based research methodology is the iterative design process. This, as a pilot study, was the first iteration. Human participants were of a convenience sample and possessed at the very least passing familiarities with the kind of concepts and thinking/outcomes this study was designed to facilitate. As a researcher, questions regarding the authenticity of the focal data have been on my mind throughout the process. Nevertheless, I trust the organic nature of how these interactions occurred and am confident the ultimate outcomes and findings will remain somewhat constant in future iterations.

Regarding future iterations, the briefly mentioned diverse intelligence considerations intervention will be tabled for the time being and deeper engagement with the historicity component of place will be elevated. In particular, I have come to recognize the necessity, both ethically and practically speaking, to center Indigenous sovereignty in this work moving forward. Not only because the study centers around Indigenous methodologies and relational epistemologies but also because Indigenous erasure and land dispossession is at the foundation of the Western world-making process that this work is committed to transitioning away from (Liboiron, 2022). This

necessitates supporting non-indigenous peoples to learn to live ethically within Indigenous sovereignty (Bell, 2024b; Carlson-Manathara & Rowe, 2021)

In sum, land-based and Indigenous approaches to education and planetary well-being are instrumental in remaking our ethical commitments to the planet, to re-considering what it means to be a good human, and how we live in deep relation with the natural world. Instead of living in fear and anxiety regarding the state of the world today as made real by colonialism and white supremacy we ought to imagine ourselves as midwives ready to birth and care for a new world.

A guiding commitment of future iterations of this study is reflected in a quote from Kyle Powys White (2019) regarding White allyship in matters of decolonization in which he states “Nobody can claim to be an ally if their agenda is to prevent their own future dystopias through actions that also preserve today’s Indigenous dystopias”. As my journey has continued it has become clear that confronting Indigenous erasure through settler colonialism and working toward Indigenous sovereignty is a central component to birthing the kind of world I want to live in and that I am working towards in this research regarding the meeting of science, place, and care. Not a mere byproduct or add-on that this first iteration has implicitly positioned it.

References

- Bang, M. (2016). *Towards an Ethic of Decolonial Trans-Ontologies in Sociocultural Theories of Learning and Development*. 24. files/318/Bang - Towards an Ethic of Decolonial Trans-Ontologies in.pdf
- Bang, M., Marin, A., & Medin, D. (2018). If Indigenous Peoples Stand with the Sciences, Will Scientists Stand with Us? *Daedalus*, 147(2), 148–159.
https://doi.org/10.1162/DAED_a_00498
- Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, 94(6), 1008–1026.
<https://doi.org/10.1002/sce.20392>

- Bang, M., Warren, B., Rosebery, A. S., & Medin, D. (2012). Desettling expectations in science education. *Human Development*, 55(5–6), 302–318.
<https://doi.org/10.1159/000345322>
- Barajas-López, F., & Bang, M. (2018). Indigenous Making and Sharing: Claywork in an Indigenous STEAM Program. *Equity & Excellence in Education*, 51(1), 7–20.
<https://doi.org/10.1080/10665684.2018.1437847>
- Bell, P. (2024a). Help Your Students Meaningfully Care about the Living World! Teach Ecological Caring Practices. Professional learning module published by the STEM Teaching Tools initiative at the University of Washington Seattle.
- Bell, P (2024b, June 13). The Development of Indigenous Allyship Among White Settlers. Poster presentation at the international Society of the Learning Sciences (ISLS) Annual Meeting, Buffalo, NY
- Bell, P. (2004). On the Theoretical Breadth of Design-Based Research in Education. *Educational Psychologist*, 39(4), 243–253.
https://doi.org/10.1207/s15326985ep3904_6
- Cajete,G.(2000). Native science: Natural laws ofinterdependence.Santa Fe,NM: Clear Light.
- Carlson-Manathara, E. & Gladys Rowe (2021) *Living in Indigenous Sovereignty*. Fernwood Publishing.

Deloria, V. (1986). *American Indian Metaphysics*. files/2055/Deloria - American Indian Metaphysics.pdf

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., Hall, R., Koschmann, T., Lemke, J. L., Sherin, M. G., & Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *Journal of the Learning Sciences*, 19(1), 3–53.
<https://doi.org/10.1080/10508400903452884>

Engestrom, Y. (2011). From design interventions to formative interventions. *Theory & Psychology*, 21(5), 598–628. <https://doi.org/10.1177/0959354311419252>

Erickson, F. (2004) *Talk and Social Theory*. Cambridge, UK: Polity Press

Escobar, A. (2020). Designing as a Futural Praxis for the Healing of the Web of Life. In T. Fry & A. Nocek (Eds.), *Design in Crisis* (1st ed., pp. 25–42). Routledge.
<https://www.taylorfrancis.com/books/9781000320053/chapters/10.4324/9781003021469-1>

Feyerabend, P.K. (1978). *Science in a free society*. London: NLB

Goffman, E. (1983). The interaction order. *American Sociological Review*, 48, 1–17.
 doi:10.2307/2095141

Goldenberg, M. J. (2006). On evidence and evidence-based medicine: Lessons from the philosophy of science. *Social Science and Medicine*, 62(11), 2621–2632.
<https://doi.org/10.1016/j.socscimed.2005.11.031>

Goodwin, C. (2018). *Co-operative action*. New York, NY: Cambridge University Press.

Gutiérrez, K. D., Hunter, J. D., & Arzubiaga, A. (2009). Re-mediating the University: Learning through Sociocritical Literacies. *Pedagogies: An International Journal*, 4(1), 1–23. <https://doi.org/10.1080/15544800802557037>

Hall, R., & Jurow, A. S. (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>

Haraway, D. (2003) *The Companion Species Manifesto: Dogs, People, and Significant Otherness*. Chicago: Prickly Paradigm Press, 2003.

Hird, C., David-Chavez, D. M., Gion, S. S., & van Uitregt, V. (2023). Moving beyond ontological (worldview) supremacy: Indigenous insights and a recovery guide for settler-colonial scientists. *Journal of Experimental Biology*, 226(12). <https://doi.org/10.1242/jeb.245302>

Kimmerer, R.W. (2013) *Braiding sweetgrass* First edition. Minneapolis, Minnesota, Milkweed Editions

Kendon (1990) *Spatial organization in social encounters - Ch 7 of Conducting interaction*. (n.d.).

Kohn, E. (2013). *How forests think: Toward an anthropology beyond the human*. Berkeley: University of California Press. <https://doi.org/10.1525/california.19780520276109.001.0001>.

- Kuhn, T. S.: (1996). *The structure of scientific revolutions* (3rd ed.). University of Chicago Press
- Latour B. (2004). Why has critique run out of steam? from matters of fact to matters of concern. *Critical Inquiry*, 30(2), 225. <https://doi.org/10.2307/1344358>
- Longino, H. E. (1992). *Subjects, Power, and Knowledge: Description and Prescription in Feminist Philosophies of Science*.
- Liboiron, M. (2021). *Pollution is Colonialism*. Duke University Press
- Massey, D. B. (2006). Landscape as a provocation: Reflections on moving mountains. *Journal of Material Culture*, 11(1–2), 33–48. doi:10.1177/1359183506062991
- Marin, A., & Bang, M. (2018). “Look It, This is how You Know:” Family Forest Walks as a Context for Knowledge-Building About the Natural World. *Cognition and Instruction*, 36(2), 89–118. <https://doi.org/10.1080/07370008.2018.1429443>
- Marin, A. M. (2020). Ambulatory Sequences: Ecologies of Learning by Attending and Observing on the Move. *Cognition and Instruction*, 38(3), 281–317. <https://doi.org/10.1080/07370008.2020.1767104>
- McDaid Barry, N., Bang, M., Bruce, F., & Barajas-López, F. (2023). “Then the Nettle People Won’t Be Lonely”: Recognizing the Personhood of Plants in an Indigenous STEAM Summer Program. *Cognition and Instruction*, 41(4), 381–404. <https://doi.org/10.1080/07370008.2023.2220852>

- Nasir, N. S., Lee, C. D., Pea, R., de Royston, M. M., Nasir, N. S., Lee, C. D., Pea, R., & McKinney de Royston, M. (2020). *Handbook of the Cultural Foundations of Learning* (1st ed.). Routledge. <https://www.taylorfrancis.com/books/9781135039318>
- Ojalehto mays, B., Seligman, R., & Medin, D. L. (2020). Cognition Beyond the Human: Cognitive Psychology and the New Animism. *Ethos*, 48(1), 50–73.
<https://doi.org/10.1111/etho.12264>
- Philip, T. M., & Gupta, A. (2020). Emerging Perspectives on the Co-Construction of Power and Learning in the Learning Sciences, Mathematics Education, and Science Education. *Review of Research in Education*, 44(1), 195–217.
<https://doi.org/10.3102/0091732X20903309>
- Pugh, P., McGinty, M., & Bang, M. (2019). Relational epistemologies in land-based learning environments: reasoning about ecological systems and spatial indexing in motion. *Cultural Studies of Science Education*, 14(2), 425–448.
<https://doi.org/10.1007/s11422-019-09922-1>
- Puig de la Bellacasa, M. (2012). “Nothing comes without its world”: Thinking with care. *Sociological Review*, 60(2), 197–216.
<https://doi.org/10.1111/j.1467-954X.2012.02070.x>
- Puig de la Bellacasa, M. (2010) "Ethical Doings in Naturecultures." *Ethics, Place and Environment* 13, no. 2 (2010): 151-69.

Melander, H. (2012). Transformations of knowledge within a peer group. Knowing and learning in interaction. *Learning Culture and Social Interaction*, 1(3–4), 232–248.

doi:10.1016/j.lcsi.2012.09.003

Sandoval, W. (2014). Conjecture Mapping: An Approach to Systematic Educational Design Research. *Journal of the Learning Sciences*, 23(1), 18–36.

<https://doi.org/10.1080/10508406.2013.778204>

Schegloff, E. A. (1972). Notes on a conversational practice: Formulating place. *Studies in social interaction*, 75–119.

Simpson, L. B. (2014). Land as pedagogy: Nishnaabeg intelligence and rebellious transformation 1. In *Decolonization: Indigeneity, Education & Society* (Vol. 3, Issue 3).

Stanford, P. K. (2019). Unconceived alternatives and conservatism in science: the impact of professionalization, peer-review, and Big Science. *Synthese*, 196(10), 3915–3932. <https://doi.org/10.1007/s11229-015-0856-4>

Taylor, K. H. (2018). The Role of Public Education in Place-Remaking: From a Retrospective Walk Through my Hometown to a Call to Action. *Cognition and Instruction*, 36(3), 188–198. <https://doi.org/10.1080/07370008.2018.1460844>

Van Dooren, T. (2014). Care Living Lexicon for the Environmental Humanities.

Environmental Humanities, 5, 291–294. www.environmentalhumanities.org

Whyte, K. P. (2019). *White allies, let's be honest about decolonization - yes! magazine solutions journalism*. YES! Magazine.

https://www.yesmagazine.org/issue/decolonize/2018/04/03/white-allies-lets-be-honest-about-decolonization?fbclid=IwAR37ol9kueO_rMLB_v1cqqs7eUY62afdXnUpPf6bDi4sQcqyfxWWkFNi-6g

Yoneyama, S. (2021). Miyazaki Hayao's Animism and the Anthropocene. *Theory, Culture and Society*, 38(7–8), 251–266.

<https://doi.org/10.1177/02632764211030550>