New Terrains for Familiar Places: Re-Conceptualizing Families Engaged in Educational Changemaking

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Abstract

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This dissertation seeks to expand a framework for families engaged in educational changemaking that emphasizes *relational- ontological, axiological, and epistemological commitments* to 'desettling' (Bang et al., 2012) partnership and pedagogy. This dissertation centers relationality as a core construct that knits social and ecological challenges with educational inequities, which disproportionately impact the "collective continuance" of nondominant students, families, and communities (Whyte, 2013). Binary and divisive politics undergird much of education (content and pedagogy) and educational partnerships (with families and communities) in ways that inauthentically and inequitably place burden and blame upon families, particularly nondominant families, to "solve" such challenges (Baquedano-López et al., 2013; Wilson et al., 2019). As educational reform efforts, including and especially research endeavors, seek to engage and partner with diverse students and families, it is necessary to better articulate and anticipate how our processes encounter, reflect, refuse, and revive diverse ways of being, knowing, and caring. This dissertation explores how binaries "quietly operate" (Bang et al., 2014) in and across efforts to engage families in educational changemaking, as well as how relational commitments may be

cultivated to rupture and subvert binary politics for collective wellbeing and educational justice in a process of 'desettling.'

This dissertation infuses critical family engagement research (Ishimaru et al., 2019, Ishimaru et al., in prep.) with insights from sociocultural (e.g., Gutiérrez & Rogoff, 2013), situated (e.g., Lave & Wenger, 2001; Bang, 2015), and cultural-historical theories of human learning (e.g., Engeström, 2001) as connected to social changemaking. Further, I draw upon Indigenous and land-based theories to ground the concept of relationality in ways that (re)orient to places, lands, waters, and more-than-human-others as consequential to learning and socio-ecological changemaking (Bang et al., 2016; Cajete, 2000; Calderon, 2014; Simpson, 2014; Smith, 2013). This dissertation utilizes micro-ethnographic methods (Erickson, 1996), knowledge in interaction analysis (KIA) methods (diSessa et al., 2015; Jordan & Henderson, 1995) and qualitative content analysis methods (Merriam & Tisdell, 2016; Schreier, 2014) to analyze data collected through co-design activities across two larger participatory design research projects.

Across three distinct empirical papers, I build out a framework for axio-onto-relationality in families engaged in educational changemaking. The first paper examines the conceptual contours of relational and divisive conceptions about families that emerged in social changemaking work across intracultural communities in a participatory design research project called Family Leadership Design Collaborative (Ishimaru & Bang, 2016). The second paper, further explores conceptions of families engaged in education as manifest in design processes and materials, and in moments of place-based co-design with educators, families, and community members in a participatory design project called Learning in Places. Finally, the third paper examines how the conceptual propositions driving the design of families engaged in science learning (described in paper 2) were concretized in "family knowledge and practice sharing tools" (i.e., homework), as well as the range of socio-ecological knowledges and practices of families' that were elicited from use of such tools in practice. I close with a reflection on axio-onto-epistemic relationality across the papers, and synthesize key implications for co-design theory and practice.

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DEDICATION

para la familia
con solidaridad
al futuro

1. INTRODUCTION

1.1. GROUNDING ENGAGEMENT WITH FAMILIES IN A SOCIO-ECOLOGICAL CONTEXT OF DIVISION AND INEQUITY

Across education research there is increasingly explicit attention to the ways that our systems of education are neither immune to rising divisive politics, which are rooted in maintaining particular nation-histories and relations (Ladson-Billings & Tate, 2016; Wilson et al., 2019), nor isolated from ecological consumption and exhaustion that disproportionately impact colonized/nondominant places and peoples (Bang et al., 2016; Nxumalo & Cedillo, 2017). That is, educational inequities are reflective of broader social and ecological challenges, both of which are dialectically shaping what we imagine as possible lifeways locally and globally (Philip et al., 2017). Indigenous scholars and activists, and solidarious allies, have long contended that such socio-ecological challenges are rooted in the perpetuation and maintenance of an onto-epistemology that desires division, separation, categorization, and hierarchization through the form of settler colonialism (Bang et al., 2016; Cajete, 2000; Wolfe, 2006; Smith, 2013; Veracini, 2011). Settler-colonial nations are those in which immigrant settlers displace Indigenous peoples from their lands and waters (e.g., Veracini, 2011; Wolfe, 2006). Settler-colonialism is the process through which settlers create societies that operate to perpetuate superiority and powered relations, positioning the idealized White/cis/male/able bodied settler as "both superior and normal; the settler is natural, whereas the Indigenous inhabitant and the chattel slave are unnatural, even supernatural" (Tuck & Yang, 2012, p. 6; see also Wolfe, 2006). This settler-colonial process occurs at multiple dimensions including (a) axiological desires for human separation from and dominance over the natural world (i.e., human exceptionalism and supremacy), alongside human differentiation and hierarchization over one another (i.e., white supremacy); (b) ontological commitments to normalizing and privileging singular lifeways such as life-long monogamy and single-family households; and, (c) epistemological dominance of Western knowledges and knowledge organization.

Pivotally, some scholars hinge the construction of such divisions in and through education and partnering processes as a key site where such educational inequities are perpetuated (Bang & Marin,

2015). These divisions, often referred to as Cartesian binaries, emerged from Enlightenment era philosophy that divided and separated human knowledge from natural phenomenon. Liberation theorist Ramón Grosfoguel (2011) writes,

> By producing a dualism between mind and body and between mind and nature, [Enlightenment theorist] Descartes was able to claim non-situated, universal, Godeyed view knowledge... Historically, this has allowed Western man (the gendered term is intentionally used here) to represent his knowledge as the only one capable of achieving a universal consciousness, and to dismiss non-Western knowledge as particularistic and, thus, unable to achieve universality. (Epistemological Critique section)

Grosfoguel goes on to describe 15 global hierarchies that shape particular socio-ecological relations and possible lifeways for all human and more-than-human communities, including global racial/ethnic hierarchy, epistemic hierarchy, pedagogical hierarchy, and ecological hierarchy. This dynamic has been largely explored in relation to how binaries perpetuate socio-ecological divides between (a) different cultural communities in relation to institutions of power (e.g., Grosfoguel, 2011; Mignolo, 2010); (b) between human communities (including their institutions) and the natural world (e.g., Bang & Marin, 2015); and (c) between human communities and scientific canonical knowledge and practices (e.g., Aikenhead, 2010; Cajete, 2000) in ways that shape educational possibilities.

It is in this broader context of socio-ecological division and hierarchization that educational systems increasingly seek to engage and partner with families in order to address educational gaps in achievement and opportunity. However, as I demonstrate in the next section, such educational efforts to engage families often fall into paralyzing binaries that hierarchically organize and privilege those particular axiologies, ontologies, and epistemologies that support Western achievement/opportunity and those that do not.

Engaging and partnering with families is increasingly leveraged as a pathway to addressing achievement and opportunity gaps (e.g., Henderson & Mapp, 2002; Jeynes, 2005). Research demonstrates that when families are engaged in their child's education, students are more likely to succeed

academically and thrive in school-based settings at all ages (e.g., Sheridan & Kim, 2015). Further, an increasing body of research calls for disciplinary-specific family engagement to help students, particularly those from nondominant communities, succeed in science, technology, engineering, and mathematics (STEM) fields (e.g., Barton et al., 2004; Caspe et al., 2018; National Research Council, 2012; Schwarz et al., 2017). There is also a growing body of scholarship that is dissatisfied and critical of the "settled" ways in which our educational systems (formal and informal) reify powered, racialized, and culturally-normative interactions, discourses, and structures when seeking to engage families (e.g., Ishimaru & Bang, 2016; Ishimaru et al., 2018; Ishimaru et al., 2019; McWayne et al., 2019). The word "settled" in this sense is a word play that describes the ease with which systems, and individuals who act within and on behalf of systems, settle into routinized patterns that maintain the status quo power and privilege of Settler society (Bang et al., 2012; Ishimaru & Bang, 2016).

Scholars critical of typical family engagement paradigms argue that family engagement often relies on deficit ideologies intended to (re)produce differentiation (based in race, class, gender, etc. in and through taken-for-granted norms, practices, and policies that maintain schools as White-controlled institutions (e.g., Harris, 1993; Ishimaru & Takahashi, 2017; Nakagawa, 2000). This occurs through assimilative and narrow axio-onto-epistemological commitments to perpetuating the status quo.

The desire to engage families in school-based education is a growing phenomenon that emerged in the 1960s as part of broad sweeping reform efforts to improve educational outcomes (Ishimaru et al., 2016; Shirley, 1997). Over the decades the shape and function of school-based family engagement has shifted from peripheral support of school-based learning to ever increasing demands for families to devote time, resources, and labor (often unpaid) within school walls and to mirror school within their own homes (Ishimaru et al., 2016). The resounding number of research studies that focus on how to get families engaged in ways that support school-based learning demonstrate the institutional *desire* for families to value school-based learning in order to support school-based success[1] (Ishimaru et al., in prep.). Those

1 As part of the Family Leadership Design Collaborative project, I was a part of a team of three graduate students that reviewed over 400 studies on school-based P-12 family engagement, parent involvement, family-school-

families who do not hail schools and school-based learning are typically considered either "bad parents" or simply need to learn the value of schooling (Baquedano-López et al., 2013). For example, through an examination of prevalent *discourse tropes*, Patricia Baquedano-López and colleagues (2013) identify four policy tropes that continue to shape (and constrain) parent involvement through a colonial agenda: (a) parents as problems; (b) parents as first teachers; (c) parents as learners; and (d) parents as choosers[2]. These tropes narrate the kinds of personhood - the traits, actions, and motives - available to parents in their interactions with educational institutions. The authors contend that these tropes promote neo-deficit, colorblind, and colonial notions of families that "support an agenda of modernity and development" in ways that deny nondominant family and community self-determination or sovereignty (p. 169, see also Mignolo, 2007). Building from liberation theorists such as Charles Mills (1997), Jennifer Keys Adair (2019) contends that positioning families' school-based engagement in light of such tropes justifies how institutions and oppressors (even unconscious ones) withhold the "rights and privileges" of "personhood" as they continually shift the requirements for personhood vis a vis successful parenting (p. 115-116).

> Mills (1997) argued that any system built on certain people needing to change to be heard, treated with respect, or be successful in society will never work because the requirements of what needs to be improved keep changing. ...If communities without power do change, those in power simply shift the requirements of success. (Adair, 2019, p. 116)

Amidst a logic that simultaneously desires familial presence and blames familial inadequacy (we might call this an axio-ontology of "parent blaming") non-Western knowledges and practices are invisibilized or actively erased in schools and in constructions of disciplinary knowledge (Carreón et al., 2005). Fabienne Doucet (2011) refers to this as a culture of pedantocracy, where knowledgeable educators and interventionists both demonstrate the inadequacy of nondominant families to engage in school-sanctioned and discipline-specific ways and then dictate to them how best to support their own

partnerships, and family leadership. The vast majority of studies promoted family engagement as near-universally "good" and offered approaches to increase the amount and efficacy of school-based family engagement without equal commitment to addressing race, culture, or powered relations (Ishimaru et al., in prep.).

2 I detail each of these tropes in more depth in paper one.

children.[3] Further, while learning can be considered a life-long and liberatory endeavor (Banks et al., 2007), many of the programs aimed at nondominant families employ subtractive practices that devalue culturally-diverse epistemologies and ontologies while offering reductionist approaches to learning in replacement (Baquedano-López et al., 2013). While a funds of knowledge approach (Moll et al., 1992) and other similarly strengths-based approaches are growing as a way to acknowledge and value the knowledges and practices of nondominant families, these approaches can reify Western-centric hegemony as educators appropriate or fit familial knowledge and practices into well-worn deficit tropes or essentializing characteristics (e.g., Auerbach, 1995; Baquedano-López et al., 2013; Ishimaru et al., 2015; Madden et al., 2013).

There is less clear commitment, across the family engagement literature, to address *settler* aims, goals, and strategies of family engagement. Indeed, it was our claim elsewhere (Bang et al., 2018b) that first articulated family engagement as also a socio-political process of *settler-colonialism*. The near silence from non-Indigenous perspectives of how land and place are conceptualized in family engagement entrenches settler-futurities. There are calls to re-orient to "home-to-school" as a new conceptual frame with dubious regard to the homeless whose "trespass" on properties owned by others is criminalized. Or to the migrant and seasonal farmworkers whose traverse of the continental U.S. and whose cultivation of lands sustains lives and livelihoods and aesthetically shapes our views and ecological futures. Or to the refugee and immigrant communities whose dis-placement from homelands and tenuous re-placement on others' suggests a misplacement of bodies. A central tenant of settler-colonialism is the "erasure of African descendants' humanity through the structuration of chattel slavery and resultant reduction to and control of Black bodies" (Bang et al., 2016, p. 34; see also Wolfe, 2006). Thus, the continued construction of nature-less home-school relations represents a "persistent historicized political act, however unintentional, in the service of settler-colonial domination and the erasure of Indigenous peoples from

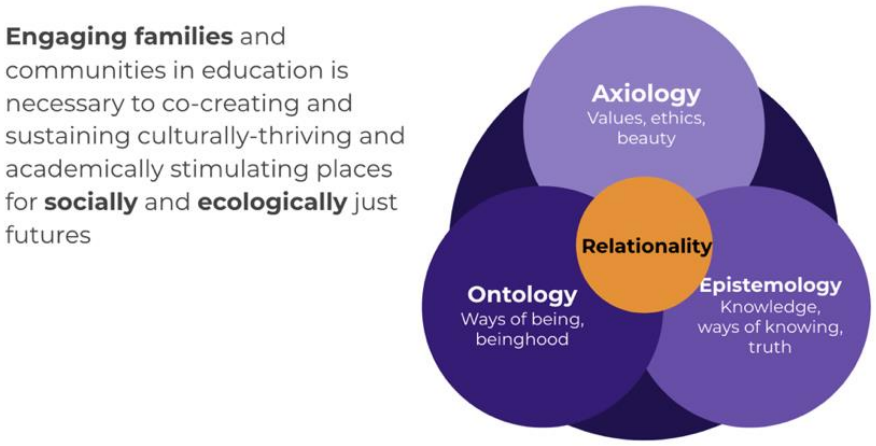
[3] This form of pedantocracy mirrors 19th century settler-colonial claims to supremacy that justified forcible removal of Indigenous peoples from their homelands and into schools through narratives of Indigenous peoples in need of saving and educating (e.g., Tuck & Yang, 2012; Veracini, 2011).

places" and the denial of "personhood" for nondominant peoples (Bang et al., 2016, p. 34; see also Adair, 2019; Bang et al., 2014). In other words, we have largely constructed family engagement as a human inter-subject issue that must reconcile cultural divides, where nature - and our relations in/on/with are present but silent.

1.2. REACHING TOWARDS AXIO-ONTO-EPISTEMOLOGICAL RELATIONALITY IN FAMILIES ENGAGED IN EDUCATION

In this dissertation I am centrally interested in how, through co-design, we might (re)create the conditions in which families and communities (human and more-than-human) might learn and thrive. In the brief review of literature above, I aimed to demonstrate that education, and thus endeavors for "family engagement," are deeply embedded in broader socio-political processes of division and hierarchization. Moves to relationality are growing to support educators in both seeing and valuing heterogeneous family/cultural knowledges-in-practice (i.e., epistemic practices) and incorporating them in pedagogical practice. This dissertation builds upon and extends this work to examine possibly new conceptual and relational landscapes in co-design research that center families and places as consequential to learning and changemaking. **Figure 1-1** represents the driving commitments to socially and ecologically just futures through axio-onto-epistemological relationality that guide this dissertation and the participatory design work from which it emerges.

Figure 1-1 Core commitment to families engaged in education



Across three distinct papers I illustrate how we might create the conditions for *axio-onto-epistemological relationality* through co-design with families, communities, and educators - by expanding and critically attending to who, how, and where we partner for changemaking; as well as attending to the kinds of semiotic resources that we can design for, that support conceptual and relational change. These papers emerge from two larger participatory design research projects, the Family Leadership Design Collaborative [FLDC] and Learning in Places [LiP]. Participatory design research [PDR] is an iterative meta-methodology that seeks to contribute to both theory and practice through collaboratively designing with people and places (Bang & Vossoughi, 2016). In this dissertation I ask three broadly interrelated design questions that are specified in each paper. As an interventionist methodology, participatory design research asks both "how can" questions that imagine new possibilities for learning and changemaking, as well as "how do" questions that inform the design and re-design of systems of activity to enact those possibilities (Bang & Vossoughi, 2016). Considering the dialectic relationship between "how can" and "how do" questions as central to learning and changemaking, then, has potential to desettle current powered and divisive relations (Bang et al., 2016). As such, these three questions are not intended to be linear, but iteratively and reciprocally sharpened across each of these papers.

1. *How can we co-design expansive learning with and for families that contributes to place-based community wellbeing and educational justice?*
2. *How do binary and relational axio-onto-epistemologies manifest in and across different co-design activity settings where families are engaged in learning and changemaking?*
3. *What heuristics and tools of families engaged in education enable or constrain particular axio-onto-epistemologies to unfold over time?*

The first question broadly frames the co-design decisions throughout the projects described in each paper as a way to specify how we collectively imagined the conditions of families engaged in educational changemaking – including the processes, practices, and sets of relations. The second question focuses on the forms of relationality cultivated (or that we sought to cultivate) as well as divisive

dynamics that emerged in unfolding designed activity. Utilizing a range of analytic methods across the three papers, I characterize both conceptual and relational possibilities and tensions that emerge in participatory work, particularly in relation to our commitments for equitable partnership. Finally, the third question highlights the affordances and constraints of our designed tools (conceptual and physical) to support individual and collective changemaking. In the following sections, I outline how each paper takes up this broader connective thread of axio-onto-epistemological relationality through analyses of conceptions about/by families, place-based co-design processes, and tool development and implementation.

1.3. ARCHITECTURE OF THREE PAPER STRUCTURE

1.3.1. *Paper 1 Overview*

In this paper, titled *Conceptualizing Families Engaged in Education: A Microethnography of Community Design Circles*, I present an empirical analysis of the conceptions about families that emerge when educational justice and wellbeing are centered as socio-political aims of co-design. I weave together and extend ideas from conceptual ecologies (diSessa et al., 2015; Kelly & Green, 1998) and ideologies in pieces (Philip, 2011) as a framework for analyzing and explicating the conceptions of families that emerged through a series of design conversations (community design circles). I offer a conceptual ecology that represents particular conceptions, and their arrangements, about families that reflect, refuse, and re-imagine particular commitments to axio-onto-epistemic relationality.

While there are well-known conceptions of families (deficit and asset-based) in the family engagement literature, these studies tend to describe these conceptions as static, ideological objects that one either possesses or, through critical analysis, rejects. Further, they reify binaries between how educators conceptualize families and how families conceptualize families. Indeed, while there is burgeoning research that suggests many families are critically aware of and challenge particular deficit conceptions (i.e., Valdés, 1996), there are fewer studies that detail how families may mobilize different conceptions of themselves and other families under differing activity systems, such as during acts of social dreaming. This conceptual framework, then, seeks to expand on Philip's ideologies in pieces

framework (2011) to consider how (a) conceptions of families are both ideological and physical, that is how they manifest in particular actions and embodiments that we must also consider in desettling projects; (b) how conceptions of families become arranged in particular configurations over time and stabilized as a coordinating class of conceptions; and (c) how conceptions of families are situated and socially shared, co-constructed, and challenged.

Research questions addressed in this paper include,

1. *How can we re-imagine families engaged in educational changemaking through co-design?*
2. *What conceptions of families emerge when community wellbeing and educational justice are centered as the aim of engaging families in educational changemaking?*
3. *How might these particular conceptions - and their arrangements - about families reflect, refuse, and re-imagine particular commitments to axio-onto-epistemic relationality.*

Data for this analysis included a secondary dataset of coded excerpts and analytic memos generated from 35 design circle transcripts from the ten Design Collaboratives across the United States. I conducted a micro-longitudinal and micro-latitudinal discourse analysis (DiLiema et al., 2015) on this secondary data set to produce a conceptual ecology that characterizes the range of conceptions about families that frame how co-designers in this space where mobilizing varied and overlapping values, ways of knowing, and possible ways of being. I find that co-designers mobilized an ecology of conceptions about families, including (a) characteristics of families that describe who is or should be engaged in education and educational changemaking, and (b) roles or functions of engagement that families engage in both in everydayness and in informal/formal learning environments. Across these two classes of conceptions, dynamics of division or reaches-to-solidarity converge and clash as co-designers envision educational justice and wellbeing in their context. I argue that explicating such a conceptual ecology in family-engaged co-design work, and in partnerships models more broadly, expands our interpretive power (Rosebery et al., 2016) to recognize settled conceptions and practices and re-mediate them towards solidarious and decolonizing forms of partnership.

1.3.2. *Paper 2 Overview*

In this paper titled *Cultivating Nature-Culture Relations in Place-Based Co-design with Families*, I conceptualize home and school relationships through place-based co-design whereby activity - and the kaleidoscope of human axio-onto-epistemologies and practices therein - takes place on dynamic lands, waters and with more-than-human others. Utilizing co-design with families, educators, researchers, and community-based organizations, I build out a framework for engaging families in education in ways that emplace science learning and families engaged in education towards nature-culture complementaries. Through an analysis of our design intentions and discourse analysis of unfolding co-design activity, I highlight accomplishments and ongoing tensions towards re-making family engaged practices. In particular, I identify a series of moments where relations with lands and waters opened space for relational conceptions of families engaged in science.

Research questions addressed in this paper include,

1. *How can place-based co-design expand conceptions of families engaged in educational changemaking for socially and ecologically just science education?*
2. *How did we design for and in what ways did nature-culture relationality manifest (or not) in our place-based co-design?*
3. *What transformative possibilities were expanded or foreclosed in our design processes?*

Data for this analysis includes design artifacts and transcripts, purposefully sampled (Merriam & Tisdell, 2016) from eight Learning in Places co-design summits between Spring 2018 - January 2020. Summits were co-design spaces where families, educators, district science specialists, researchers, and representatives of community-based organizations came together. These spaces served to collaboratively design the field-based seasonal science model (and concrete activities and materials therein), to provide professional development for co-design and racial equity in science learning, and to build relationships across places and organizations. These were also public spaces where conceptions of families and places in science learning and educational changemaking were collectively narrated and negotiated over time.

I conducted a design analysis of the objectives and activities where families were centered in co-design activity. I present findings on a series of design practices that worked in complementary ways to re-mediate family engagement from disciplinary-agnostic and place-abstracted forms of partnership towards expansive learning and changemaking. I further argue that this approach to employing an ecology of practices (i.e., rather than singular strategies) was taken up by our co-design partners in their routine practice engaging families. Secondly, I conducted a micro-ethnographic analysis (Erickson, 1996) of transcripts to understand the conceptions of families as they emerged and were negotiated across the eight summits. Using these moments, I argue that conceptualizing home-school relations through a re-orientation to lands, waters, and places opens space for attending to the contradictions between home-school activity systems in ways that may disrupt Cartesian binaries as well as find home-school "paradoxes" (Ishimaru & Takahashi, 2017) as generative for transformative changemaking. Such a view envisions and seeks to enact home-school relations as potential sites for sustaining diverse families and communities, and also sustaining the lands and waters *with which* we live. Further, situating home-school relations in this way enables us to better understand settler-colonial impacts to both human and natural activity systems.

1.3.3. *Paper 3 Overview*

This dissertation paper, titled Re-Configuring Home-School Practices Towards Expansive Science Learning, describes the co-design, implementation, and preliminary findings from an analysis on material tools, called *family knowledge and practice sharing tools* [FKPS], created as part of a larger NSF-funded participatory design research project that engages young children, educators, families, community leaders, and university-based researchers in field-based seasonal science learning. These tools were designed to elicit and facilitate socio-ecological investigation, deliberation, and decision-making in the places that matter to students, families, educators, and the broader communities in which they live. I conducted a design analysis of three FKPS tools and a content analysis of these tools after families completed and returned them to their classrooms.

Increasingly, there are calls to move science education beyond a set of known facts to memorize, towards active inquiry and sensemaking based in real-world phenomena (NRC, 2012; Schwarz et al., 2017). The project described in this paper takes field-based science learning as foundational to making learning consequential to students and families, and authentic to what scientists *do.* Field-based science places students in the sites where socio-ecological phenomena manifest - that is the "field." Studies in teaching and learning about complex systems demonstrate both its necessity and difficulty (e.g., Grotzer et al., 2013, 2017; Hmelo-Silver & Azevedo, 2006; Hmelo-Silver et al., 2017). As discussed in the introduction to this paper, understanding ever-changing relations and impacts to our social and natural world at both the individual and societal levels as well as local and global levels is a grand challenge of our time (Berkes, 2017). The family knowledge and practice tools in this study were designed to act as both mediational devices, eliciting and facilitating critical scientific thinking and practices (Wertsch, 1994; Nolen et al., 2020), as well as boundary objects (Akkerman & Bakker, 2011) that supported Next Generation Science Standards-aligned investigations across places. In particular, we intentionally scaffolded for routinized sensemaking habits bridging indoor (in classrooms and in homes) and outdoor (in school yards, gardens, and local greenspaces) science learning. The analysis and findings taken up in this paper centralize the importance of designing for meaningful home-school practices that open space for complex socio-ecological systems learning. As such, this paper focuses on describing the design characteristics of the tools as they relate to our design propositions as well as a content analysis of familial knowledges and practices elicited by the tools.

Research questions addressed in this paper include,

1. *How can homework tools re-configure boundaries between home-school relations, knowledges, and practices related to expansive field-based science learning?*
2. *What kinds of epistemic practices and knowledges, specifically in relation to our core design propositions, were elicited from families using these tools?*
3. *What design characteristics of our activities and tools afford and constrain expansive science learning?*

For this analysis, I conducted a design analysis of three FKPS tools and the activities and system of activities in which they were embedded to articulate our design intentions as related to our core propositions for equitable science learning. I focus on three learning engagements (LE) – that is interconnected activity systems – that seek to elicit place-based knowledge and practices from students and families as well as framing aspects of the project that can be built upon during later learning engagements. Across these learning engagements, we designed a series of activities that spanned indoor/outdoor and classroom/home/neighborhood places. These tool-mediated activities included (a) indoor and discursive activity, and (b) outdoor, mobile, and discursive activity. A core facet of this analysis is understanding how the different participation structures elicited by the tools may have facilitated different conceptual landscapes. Secondly, I conducted a qualitative content analysis of implemented tools. Data for this analysis included implemented FKPS tools from our science model as of January 2020 (n = 58 tools). A coding scheme was developed aligned with the literature on complex socio-ecological systems and nature-culture relations and applied across the implemented family tools.

I find that families engaged in complex systems thinking across spatial and temporal scales and expanded and refined our theorizing about the kinds of relevant experience and practices families – particularly immigrant families – bring to science learning. I also find that the indoor activity reinforced conceptions of humans apart from the natural world (i.e., nature-culture divides). Additionally, I find that outdoor, mobile activity expanded opportunities for families to observe and ask scientific questions about socio-ecological phenomena, and afforded opportunities to reason complexly about the behaviors, characteristics, and relationships of more-than-human species and kinds. Implications for this work include ongoing critical attention to design dimensions that support families engaged in expansive science learning.

1.3.4. *Reflection Overview*

Following the three papers, I return to the three broad design questions put forth in this introduction. In particular, I synthesize these findings in light of the current moment in which I write the conclusion of this dissertation – a moment in which divisive politics between schools and families are

being uniquely ruptured in the face of global pandemic. The questions posed and findings shared in this dissertation suggest that the discourse around how to conceive of- and actualize roles for- families engaged in education (without the boundary of a school building) is brimmed with possibility for new forms of relationality and learning with/on lands and waters – yet the perils of division and deficitizing evidenced in these studies are also amplified in the "unknown." This discussion, then, serves as hopeful – and cautious – reflection on families engaged in education and educational changemaking as we navigate the terrains of familiar – and unfamiliar – places.

2. PAPER 1: CONCEPTUALIZING FAMILIES ENGAGED IN EDUCATION: A MICROETHNOGRAPHY OF COMMUNITY DESIGN CIRCLES

2.1. INTRODUCTION

Despite a battery of efforts to engage families in education reform, systems of education (i.e., p-12 public schools, private schools, before/after school programs, wrap around services, etc. continue to be sites where epistemic and ontological violence are inflicted on nondominant students and where families and communities are implicated in and often blamed for disparities in educational outcomes (Baquedano-López et al., 2013; Fryberg & Bang, 2018; Ishimaru et al., 2019). Scholars, practitioners, and families are increasingly dissatisfied and critical of the "settled" ways family engagement research and practice reifies powered, racialized, and culturally-normative interactions, discourses, and structures (e.g., Ishimaru & Bang, 2016; Ishimaru et al., 2018; Ishimaru et al., 2019; McWayne et al., 2019). These scholars argue that typical family engagement practices rely on deficit ideologies intended to (re)produce differentiation (based in race, class, gender, etc. in and through taken-for-granted norms, practices, and policies that maintain schools as White-controlled institutions (e.g., Ishimaru & Takahashi, 2017; Nakagawa, 2000; Wilson Cooper, 2009).

Concurrently, there are burgeoning efforts to centralize the role of families in social changemaking towards transformative agency and expansive learning (e.g., Bang et al., 2016; Ishimaru & Bang, 2016). In particular, methodological and theoretical insights from the learning sciences and participatory design research (PDR) offer alternative approaches to engaging families that directly address historically inequitable dynamics in institutional partnering practices and ground changemaking in the lives and possibilities of families and communities. Participatory design research (PDR) is an iterative research methodology that seeks to expand learning theories as grounded in the lives, experiences, and local theories of justice and wellbeing of communities through co-design (Bang & Vossoughi, 2016; Ishimaru et al., 2016). As such, learning and social changemaking are "co-created and grounded in the cultural historical practices of the communities involved" (Gutiérrez & Vossoughi, 2010, p. 100). Further,

role re-mediation, a central aspect of PDR, elucidates how we can create the conditions under which we might expand subject-subject relations as well as the object of activity (Bang & Vossoughi, 2016). Subject-subject relations are the unfolding and always becoming interactions between individuals, and individuals and their environment that shape how knowledge and action are co-created. Historicized dynamics in institutional partnerships (e.g., between families and schools, and communities and research universities) are often predicated on and reproduce hierarchical roles and relationships (Ishimaru et al., 2018; Ishimaru & Takahashi, 2017). Role re-mediation seeks to expand those sets of relationships within our design spaces (who) as well as the processes of partnership to address powered dynamics between individuals (how). Expanding with whom and how we partner with families, I argue, leads to new theories of educational (in)justice as well as solutions that attend to the here-and-now realities of co-designers while re-mediating the accumulation of here-and-then inequalities (Hall et al., 2020).

This paper presents findings from an analysis of a national participatory design research project, the Family Leadership Design Collaborative (Ishimaru & Bang, 2016; Ishimaru et al., 2018; Ishimaru et al., 2019). In this project, we leveraged an innovative practice of participatory design research, solidarity-driven co-design, which seeks to enact PDR principles of attending to power, critical historicity and relationality in the *process* of partnering and designing with families (Bang & Vossoughi, 2016; Family Leadership Design Collaborative, 2017; Ishimaru et al., 2018). Solidarity-driven co-design was our way of re-mediating the role of families and communities in educational changemaking. Through solidarity-driven co-design activities and practices, we sought to expand who gets to theorize and design educational changemaking as well as the process of design-work to build upon community ways of knowing, being, and deliberating. This paper focuses on Phase 1 of the project, in which we collaborated with 10 community partners across the United States, in what we called Design Collaboratives, to identify community-specific definitions and possibilities for community wellbeing and educational justice (Ishimaru et al., 2018; Family Leadership Design Collaborative (FLDC), 2019). Design Collaboratives represented heterogenous geographic, linguistic, cultural, and racial communities as represented in the map in **Figure 2-1** (Family Leadership Design Collaborative, 2019, p. 3). Each Collaborative was

facilitated by a community member and university researcher who brought together a range of individuals with roles in families, communities, and educational systems (i.e., parents, grandparents, school administrators, community leaders, etc.). Collaboratives hosted between 3-4 community design circles to identify challenges to educational (in)justice and community wellbeing, and envision solutions. Refer to **Appendix 2-A** for summary of design collaborative contexts and co-design participants and facilitators[4].

Figure 2-1 *Illustration of design collaborative geography and context overview*

Note. This image is adapted from the original, which appeared in the Family Leadership Design Collaborative, *By the Numbers Report*, 2019

In this paper, I articulate a conceptual landscape about families and their perceived roles in education and educational changemaking emergent from community design circle conversations. I argue that how we conceptualize "families" matters for how their roles are actualized in education and educational changemaking – that is, for role re-mediation. Further, conceptions about families engaged in

[4] For this paper, all Design Collaborative locations, partnership organizations, and co-design facilitators/participants are given pseudonyms. Numbering of Design Collaboratives was random.

education are steeped in powered and historicized socio-political paradigms that are rooted in our collective imaginaries, as such ongoing vigilance is necessary to our changemaking work. As such, I intentionally use the term "families engaged" in place of the more familiar term in education "family engagement." Doing so enables me to begin with the premise that families already are committed to and active participants in the education of young people – they are already engaged – and it is the work of institutions of education to better honor and enhance those forms of engagement across learning environments.

In this paper I ask,

1. *How can we re-imagine families engaged in educational changemaking through co-design?*
2. *What conceptions of families emerge when community wellbeing and educational justice is centered as the aim of engaging families in educational changemaking?*
3. *How might these particular conceptions - and their arrangements - about families reflect, refuse, and re-imagine particular commitments to relationality.*

2.2. THEORETICAL FRAMEWORK

Conceptions of families and their role in education reflect broader socio-political ideologies about domesticity, parenthood, and education as a force for instituting social order in families' lives (e.g., Baquedano-López et al., 2013; Doucet, 2011; Nakagawa, 2000). I use the term "conception" here to denote the subjective idea of or about something as well as the intersubjective - or public - character of knowing (as an object). In other words, knowing who and what families are is both subjective to personal experiences - perhaps as a family member, as an educator, as an education researcher, etc. - as well as public discourse about families that are ubiquitous in societal discourse. These conceptions shape not only how we believe families should be engaged in education, but how we design for and facilitate particular opportunities for engagement. These conceptual imperatives are steeped in scholarship that reinforce this dynamic. For example, the work of Joyce Epstein is highly influential in school-based settings and research on family engagement, and, despite many critiques, continues to shape how policy and practice unfold in family engagement (Epstein, 1995, 2018; Epstein & Connors, 1992; Epstein & Sheldon, 2002).

Most prevalent is the typology of involvement that outlines how educational institutions can partner with families to support academic outcomes and build mutual relationships. These include parenting, communicating, volunteering, learning at home, decision-making, and collaborating with communities (Epstein, 2018; Epstein & Sheldon, 2018). For example parenting is defined as "helping all families understand child and adolescent development and establishing home environments that support children as students." From this typology emerges a set of conceptions that position families as supportive (or hindering) the academic achievement of their students in school settings. Critiques of this model argue that this framework neither attends to power dynamics (based in class, race, language, citizenship status, etc. in family-school interactions nor radically alters educational decision-making processes (e.g., Auerbach, 2007; Fernández & López, 2017; Ishimaru et al., 2018; Schutz, 2006; Wilson Cooper, 2009). The purpose of this paper is to expand our sensemaking repertoires about the kinds of conceptions about families engaged in education that are developed and mobilized in collective discourse and action towards wellbeing and justice and those that are not.

2.2.1. *Understanding "Conceptions" through Tropes, Cultures, and Scripts*

This idea of conceptions in family engagement scholarship has been tangentially explored in myriad ways, such as "tropes," "cultures," and "scripts" that define how systems of education tend to value middle class, usually white, families' ways of knowing and being, and how this valuing might define practices of family engagement. For example, Baquedano-López, Alexander, and Hernández (2013) detail four policy discourse tropes that frame how schools often approach families and communities, particularly focusing on those families deemed problematic. These include (a) parents as problems; (b) parents as first teachers; (c) parents as learners; and (d) parents as choosers. These authors trace a historical legacy of parent involvement that emerged from (a) nation-state building goals in the 19th century that sought assimilation into idealized citizenship for Native American and immigrant families; (b) blamed parents for the "failing" achievement of nondominant students in schools in the mid 20th century; and (c) is increasingly seeking to remedy discrepancies between school and home cultures through increased access to and education about school-based practices for nondominant families. They

argue neodeficit, colorblind, and colonial notions of families undergird family engagement imperatives and "support an agenda of modernity and development" in ways that deny nondominant family and community self-determination or sovereignty (p. 169, see also Mignolo, 2007).[5]

Perhaps the most explicitly deficit trope, "parents as problems" frames families as uncaring and harmful to children's academic success and life opportunities. Reflected in policy discourse about "high risk" families, this conception about families reinforces negative stereotypes about race, class, gender, etc. and frames educators and educational systems as safe spaces for children to escape their harmful communities (Whyte, 2015). The "parents as first teachers" trope contends that learning begins at birth and parents (and other adult caregivers) provide the necessary foundations for successful entry into schooling (Baquedano-López et al., 2013). This is often constrained by what Doucet (2011) calls a "culture of domesticity" that constructs good parents and good teaching from idealized and Anglocentric notions of the nuclear family. The "parents as learners" trope suggests that parents, especially those who are not considered good "first teachers" need special guidance and material resources to appropriately support children in school-sanctioned ways. This trope often "challenges parents' knowledge base and community wisdom by constructing the image of stultified adults in need of guidance" (Baquedano-López et al., 2013, p. 53).

Finally, the "parents as choosers" trope contends that parents make informed and beneficial decisions on behalf of their own children. Baquedano-López and colleagues (2013) contend that this trope is predicated on neolibral agendas that promote individualism, consumerism, and competition between families (particularly between nondominant families). This trope includes market-driven reform efforts that rely on "parent power" as well as individual choices that parents make to supplement their child's education through volunteerism in the classroom, museum attendance, participation in after-school

[5] Others in the field build from this work to argue that the historical legacy of family engagement sought to engage not only colonial desires to subordinate nondominant families into deference and dependency on nation-states through schooling efforts, but also settler desires for land and commodity of enslaved, immigrant, and indigenous bodies (Bang et al., 2018b). I use "(settler) colonial" here to signal that, although Baquedano-López et al., (2013) do not explicitly connect settler desires for land to parent involvement, attending to settler-colonialism offers a more robust understanding of how the four tropes outlined by the authors manifest.

activities, and access to material resources such as technology, books, kits, etc. Parent power and choice in this way is constrained by what Derrick Bell (1980) refers to as "interest convergence" where the ability of nondominant people to self-determine their own educational opportunities and collectively enact their will is allowable when and only if it also aligns to neoliberal ideals and increases the wealth and power of select Whites (Garces et al., 2017; Marker, 2006).

These conceptions of families are mobilized and weaponized throughout education policy, research, and practice, with real consequences for families and communities. Through a critical discourse analysis of federal, state, and district policy texts, Nakagawa (2000) demonstrates that family engagement policies and practices often blame families for educational inequities while justifying unequal power and resource distribution (see also Fryberg & Bang, 2018). These policy texts leverage taken-for-granted conceptions of families as beneficiaries and deferent to institutional power. Put simply, because some families do not embody the idealized engaged family they do not deserve high quality education (Nakagawa, 2000). Families are thus placed in a "double-bind" where they are told they are both the cause of- and only solution to educational disparities (Nakagawa, 2000, p. 448).

Ishimaru and Takahashi (2017) and Doucet (2011) are interested in the ways that particular interactions between families and school systems unfold in routinized patterns that privilege idealized families (i.e., White, middle-class, nuclear families) and exclude all others. Doucet (2011) articulates these as a set of "ritualized practices" that make up particular family-school "(cult)ures" that signal "broader societal messages and norms about gender, race, class, ability status, sexuality, and other characteristics used to distinguish 'the mainstream' from 'the marginalized'" (Doucet, 2011, p. 404).

These ritualized practices form what Doucet (2011) refers to as (cult)ures of domesticity, capital, and pedantocracy that socialize linguistically, culturally, and socio-economically diverse [LCSD] families into dominant culture while simultaneously positioning them as marginal and therefore beneficiaries of dominant society. Similarly, Ishimaru & Takahashi (2017), approach these dynamics as a set of "racialized scripts" that "maintain organizational norms, structures, and interactions in schools" (p. 350). They are explicit in how these particular relationships and tropes are racialized. For example, they write:

> [The] "problem parent" is often associated with African American (and sometimes African immigrant) parents who challenge educators in what are often perceived by (white) educators as "destructive" ways that interfere with or derail their child's achievement and undermine the professional authority and expertise of educators. (p. 348)

Drawing upon Lareau and Horvat's (1999) pivotal study, Ishimaru and Takahashi (2017) describe how White families may exhibit similar interactions with schools yet their actions are perceived as positively advocating for their children. In other words, individuals rely on particular conceptions *about* families that reflect powered and divisive dynamics based in race (among all other forms of intersectional identity) in order to *interpret* and respond to interactions. Further, many families are explicitly aware of these racialized dynamics and have developed robust strategies to advocate for their own children and other children in collective care (Wilson Cooper, 2009).

There have been movements in the field of family engagement to counter these deficitizing conceptions by demonstrating how families can and do contribute to the everyday education of their young people, while interrogating the racialized and inequitable practices in school-based settings (e.g., Ishimaru et al., 2019; Ishimaru in prep.). To combat deficit conceptions of families, educators are increasingly encouraged to take an asset frame when approaching families to see and acknowledge their contributions to education. However, Kristin Whyte (2015) cautions that educators may use family stories and experiences gleaned from home visits and interactions in communities and schools to confirm previously held deficit conceptions. In a narrative case study of Princess, a 35-year-old, White, early childhood educator in the Midwest, Whyte provides of an example of how strategies that seek asset frames can engender both positive and negative conceptions of families. She writes,

> Princess has plenty of stories to tell about the families she works with. Some of the stories have to do with learning about families' home practices that she considers positive...She also occasionally uses stories to combat stereotypes about poverty-stricken neighborhoods and the families living in them...These stories, however, are not the ones Princess typically tells...These stories reinforce a

statement she repeatedly expresses about children "You learn that they come from chaos, so they're going to create chaos because that's all they know." (Whyte, 2015, p. 92)

In this particular case, we see that Princess holds multiple conceptions of families in her sensemaking. She, presumably, seeks to learn more about families and their practices while combating deficit stereotypes. Yet, deficit conceptions of families in poverty - as creating chaos - continue to shape how she interprets families, children, and people in poverty more broadly. Even in social justice-oriented stances towards families and communities, deficit conceptions may continue to frame analysis and the narratives constructed of how and why educators need to engage families. These conceptions continue to dichotomize good parenting and bad parenting, even as they expand what counts as "good" or caring behavior as power and racialized, classed, and gendered dynamics go under examined (Wilson Cooper, 2009). I argue that while there are well-known conceptions of families (deficit and asset-based) in the literature, these studies tend to describe these conceptions as static, ideological objects that one either possesses or, through critical analysis, rejects. Yet, as the instance of Princess (above) suggests, individuals can hold multiple, and even contradictory, conceptions of families simultaneously as individuals make sense of phenomenon across activity systems. The purpose of this paper is to expand our lens for "seeing" and interpreting the range and differing arrangements of conceptions about families engaged in education. Doing so might account for how settled[6] (Bang et al., 2012; Harris, 1993; Ishimaru et al., 2018) conceptions of families narrowly constrain their/our engagement in education and educational changemaking; and - just as importantly - how we might open space for expansive conceptions to take root.

2.2.2. *Extending "Ideologies in Pieces" and Conceptual Ecologies to Conceptions of Families Engaged*

I build upon and extend the work of Thomas Philip (2011) *ideologies in pieces* and Andrea diSessa *knowledge in pieces* (1988, 2002) to consider how conceptions of families are (a) ideological and

[6] Settled conceptions include those ideations of families rooted in systemic hierarchies and division that reproduce inequities in learning opportunity and agency.

physical, (b) become arranged in particular configurations over time and stabilized as a coordinating class of conceptions, and (c) are situated, socially shared, co-constructed, and challenged. In working to make sense of how educators think about and enact social justice, particularly around race and racism, Philip (2011) puts forth a framework that attends to the underlying ideological "pieces" that make up teacher sense-making repertoires. Philip draws upon Hall's (1982, 1996) theory of ideology and diSessa's (1993) theory of conceptual change to elucidate how teachers' sensemaking is neither static nor uniformly or universally applied. Instead, he argues that "teachers' taken-for-granted assumptions are socially shared and are reflexively related to a racially stratified society" (Philip, 2011, pp. 299-300). Two convergent concepts frame this understanding: naturalized axioms and phenomenological primitives (p-prims). Both refer to the underlying cognitive elements - or smallest units - of common sense through which individuals make sense of experience and help explain and predict patterns in the world. For diSessa (1988, 1993), human knowledge is made up of these p-prims that are context dependent and, because they are personally experienced and held, can be difficult to conceptually change. Naturalized axioms, similar to p-prims, are cognitive elements that "people use in their social sensemaking" that are also often personally experienced and socially constructed (Philip, 2011, p. 302). In both cases, the underlying cognitive element is so common sense or ubiquitous as to be unquestioned.

Further, p-prims/naturalized axioms are organized (and re-organized) into coordinating classes that stabilize in routinized patterns. For example, Philip (2011) suggests that a coordinating class in teacher education might be "teachers blaming students" as a set of naturalized axioms that explain how and why some students fail to succeed in school-based settings. This coordinating class is made up of several naturalized axioms including: "their parents don't care", "these students just don't care about school", and "my Asian kids did so well!" (Philip, 2011, pp. 304-305). Across these naturalized axioms and embedded within this coordinating class, power operates to solidify the ideation that students and families are apathetic or problematic. Further, racialized dynamics differentially shape these how educators interpret (or apply an axiom or coordinating class) to students in their classroom.

In considering how conceptions of families engaged in education become arranged, stabilized, and destabilized over time in collective activity, I draw upon conceptual ecologies (Kelly & Green, 1998). Building upon socio-cultural theories of learning, conceptual ecologies highlight learning and knowing as agentic, collaborative, and situated processes whereby members "shape and frame what counts as knowing, doing, and being within the group" (Kelly & Green, 1998, p. 155). Conceptual ecologies are not static; rather they are dynamically shaped by members within a group as they draw upon diverse semiotic resources including previous experiences, values, and frames. That is, they are culturally mediated. Kelly and Green (1998) offer a helpful definition,

> [A] conceptual ecology is constituted through the interactions among members; it is not a static entity defined solely by membership or formal identity. Concepts, then, are the outcomes of negotiations among members of a sustaining group. The stability of concepts is reflected in the ways that members take up, use, and maintain the concept in and through their discursive processes and cultural practices across time. Thus a conceptual ecology is not a fixed entity or static body of knowledge; rather, it is a dynamic, evolving, and developing system of ideas, concepts, and practices shaped by members of a local group. (p. 155)

Additionally, conceptual ecologies can highlight the tensions, paradoxes, and possibilities for decolonial and resurgent collaborative work in ways that do not collapse complexity. Because conceptual ecologies are situated processes, attending both to the ecology as well as the process by which ecologies emerge is integral to understanding the complexity (Bang, 2015). I bridge ideologies in pieces and conceptual ecologies here to highlight how conceptions of families refract broader socio-political ideologies and unfold in collective knowledge making as a complex process.

Extending this framework to families engaged in education, conceptions of families are often naturalized assumptions about families that reflect broader ideological discourse about families and their roles as parents and in education, that are also personally reinforced through everyday interaction. These conceptions become configured in routine patterns that solidify over time into coordinating classes. As individuals make sense of families engaged in education, they employ these conceptions as embedded

within conceptual classes. For example, the "parents as first teachers" policy trope might be extended as a kind of coordinating class of conceptions about parenting and family engagement that is ubiquitous in how we construct particular relationships and roles. Further, this coordinating class of conceptions is mediated by race, gender, age, language and socio-economic status in ways that marginalize and blame nondominant families, while privileging dominant families, especially those that fit the idealized family. Important to note, this coordinating class is not only applied by those in normatively powered positionalities nor are they applied with deliberate malintent. I illustrate this claim in the following excerpts from two community design circles in Design Collaborative #5. This Collaborative emerged in a rural, southern, predominately African American community. In these design circles, the coordinating class of "parents as first teachers/parents as learners" was mobilized, weaponized, and disrupted as co-designers made sense of their role in early childhood educational justice and community wellbeing (see **Appendix 2A** for list and description of design collaboratives).

The first quote occurred in conversation approximately half-way through the first design circle after several co-designers - mostly African American early childhood education (ECE) center directors/owners and district ECE support specialists - identified core academic goals for young children and shifted to discussing barriers to meeting these goals. One goal included "Kindergarten readiness" as measured in the district by a working vocabulary of over 4000 words (Hart & Risely, 1995; see Adair, 2019; Solis & Callanan, 2018 for critique). Several co-designers conceived that many of the children in their care, but especially those children who are not in center-based care of any type, do not perform a working vocabulary of 4000 words. For Ms. Thomas, her analysis of the "problem" centered around parents' who do not provide opportunities for their children to learn vocabulary in the home. Ms. Thomas is an African American faculty member of a local university that certifies and trains early childhood educators.

Ms. Thomas explained,

1 What we've got to do now is, we've got to teach parents... if our parents are young and I think
2 that's one of the variables as to why we're having so many difficulties in our smaller communities

3 where parents don't really know about responsibility or accountability even with children. We've
4 got to teach parents as well, so if we're teaching their children we've got to teach [the parents] and
5 we've got to be kind of intrusive. We've got to be intrusive. (Ms. Thomas, Design Collaborative
6 #5, design circle 1 transcript)

Ms. Thomas mobilized the conception that parents, specifically African American young parents, do not "know about responsibility or accountability" (lines 1-3) within her broader caste of parents as first teachers/learners (lines 4-5). Geronimus (2003) contends that this deficit conception about the skills and capacities of young parents, specifically socio-economically disadvantaged African American families, is well rooted in dominant societal imaginary and reinforced in policy and practice as an unquestionable societal-ill, despite increasing evidence to the contrary (e.g., Geronimus, 2003). She writes,

> Well-publicized conventional wisdom continues to hold teen childbearing to be, in all cases and in every aspect, an antisocial act and an important public health problem, *especially* when practiced by urban African Americans. Meanwhile, a significant body of reputable scientific evidence has existed for more than a decade that casts doubt on the conventional wisdom but does not get the same airtime...This may occur because myopia on this issue is useful to the dominant culture to the work of parents in the dominant group…[T]he public 'damning' of African Americans for early childbearing helps European Americans rationalize and perpetuate their dominant status and its associated benefits. This condemnation does not require the conscious intent of European Americans. (Geronimus, 2003, pp. 881-882)

Whether the parents of community, *in actuality*, know nothing about responsibility or accountability or are in fact teenage parents is of little salience to the analysis of the problem in early childhood education. Rather, Ms. Thomas leveraged a conception that has rhetorical power to create a conceptual landscape that envisions parents as deficient, and therefore to blame for the poor academic outcomes of African American children in the school district. Further, this conception has deep roots in the vocabulary measurements of Kindergarten readiness based on the well-publicized research study by Hart and Risely (1995) known as the "word gap" of socio-economically disadvantaged African American

families that has increasingly been critiqued and debunked (e.g. Sperry et al., 2019; Kuchirko, 2019). I do not presume that Ms. Thomas was aiming to "rationalize and perpetuate [European American] dominant status and its associated benefits (Geronimus, 2003, p. 882) in her analysis of the problem in the community. Instead, I argue here that the conceptions about families in education broadly, and early childhood education specifically in this instance, are often deeply saturated in broader settler-colonial imperatives that are often invisible, imposed, or taken-for-granted. When considering the disproportionate outcomes of African American students, the kinds of conceptions about students and families available to educators (at all levels of institution pre-K through higher education) remain starkly deficit in tone and practice. In other words, situating educational inequity from the frame of academic outcomes created a semiotic landscape (Goodwin, 2003) that conjured settled conceptions of families and articulated them as poor first teachers and in need of education about appropriate child rearing and educational practices.

This conceptualization also centrally upheld the position of early childhood education and the role of educators in the community as necessary to the success of young children and their families. All the co-designers in this Collaborative held formal roles in educational institutions and did not identify themselves as parents or parts of extended families in their introductions to one another. Rather, role re-mediation in this Collaborative focused on addressing competition and siloing *between* organizations and institutions that led to "so many children just falling in the cracks" (Ms. Jolene, early childhood center director, Design Collaborative #5, design circle transcript 3). By the third design circle, the object of co-design shifted beyond academic achievement to more broadly consider community wellbeing, and the role of this Collaborative in achieving this wellbeing. While deficit conceptions of young families and intergenerational families continued to emerge in assessment of challenges to wellbeing, the focus was on reclaiming communal resources to combat poverty. Further, many of the deficit conceptions of families were challenged as co-designers pivoted to assessing the role of other institutions (such as department of social services, housing, or gas and electric companies) in further disenfranchising families. For example, they narrated a "code of silence" that pervaded both educator and familial reticence to involve formal institutions in assessing the need of families or in attending preschools for fear of judgement or familial

fracturing and forced removal (Design Collaborative #5, design circle 3 transcript). They also spoke of reclaiming communal and familial forms of care and kinship to support families in need as an alternative to governmental services. To exemplify this, I animate an excerpt from the third design circle. Ms. Jones is an African American community leader and the lead facilitator of this Design Collaborative. In the following excerpt, Ms. Jones identified culturally thriving communal practices for care in the historical fabric of the community. She said,

> I still say, we got to bring some, I'm just using the churches because I don't know any other bigger organization in our communities, Black communities anyway. We need to target and say, "hey look, how do we get you all organized in a way that you're looking at communities around your church." When you [speaking to the ECE educators] all are saying, if they [families] have a problem, who do they call, we need to make sure that our churches are the ones that they can call...How many blocks in the radius of your church can you all have capacity to support? You know what I'm saying? …
>
> The other part of it is, who in that community, just think about back in slavery time, because they [grandparents] made it. They made it by doing a collective community. Y'all know we, all of us, we not that far from that family generation where everybody helps each other. (Ms. Jones, Design Collaborative #5, design circle 3 transcript)

Ms. Jones was responding to the story of a family who were harmed in a fire caused by using the gas stove to heat the home when the electricity was turned off. Members of the Collaborative said that this situation was not an isolated incident, but endemic to a community impacted by rural isolation, defunding of public services, and disenfranchisement. Ms. Jones' narrated getting community churches, well-off individuals, and others in the community organized in a solidarious support network. This network would need to center familial wellbeing over their own interests and competition that led to "cracks" in the system. Importantly, this contrasts the overtly deficit tones and conceptions of perceived irresponsibility of young families, and instead draws upon a historical resiliency and collective care in the community. Ms. Jones also shared stories of her grandmother and the grandparents of others in the room

and the kinds of resources these elders drew upon to survive and take care of the community. Drawing upon Black feminist and womanist theory, Wilson Cooper (2009) argues that this kind of collectivist care is integral to the wellbeing and justice-seeking endeavors of African American communities. I argue that as co-designers shifted their conceptions of the "problem" from individual academic preparedness and achievement towards collective wellbeing, the conceptual landscape also shifted. Deficit conceptions continued to emerge, but were framed as non-agency within the face of systemic injustice across multiple institutions (educational, social, and political).

Role re-mediation was important to this shift. Early childhood directors and educators came into the design space from their formal positions as business operators and competitors to care and prepare young children for academic success, but reframed their roles as a collective body working to support all children and families to achieve wellbeing (educational, social, and economic). I highlight here that as relational dynamics shifted so too did the conceptual landscape shift towards a relationality that drew upon values, knowledges, and ways of being in community from previous generations of Black thrivance through collective care. That is, there was a reach for axio-onto-epistemic relationality between co-designers and a hope for relationality with other organizations and institutions to better support families. Yet even in this reach, families were conceptualized as deficient and/or as beneficiaries of a better system. This represents an ongoing necessity for vigilance in our design work to honor the transformative shifts, while also keenly watching for settled enclosures (Bang et al., 2014).

2.2.3. *Summary of Theoretical Framework*

My goal in this brief analysis was to illustrate how an ideologies in pieces (Philip, 2011) approach to conceptions of families can further our understandings of the conceptual resources individuals use in their sensemaking about the role of families in education and educational changemaking. Further, I aimed to draw attention to these conceptual resources as cued by salient features of the context, including the kinds of subject-subject relations that unfold in activity as well as the framing of educational justice and community wellbeing. Finally, that increasing our interpretive power to intervene in and disrupt settled conceptions of families engaged in education requires ongoing critical

attention to how power and historicity shape these conceptual landscapes as they stabilize in individual and collective knowledge making (Bang & Vossoughi, 2016; Ishimaru et al., 2018). Particularly in co-design, and allied social-justice oriented projects, being able to anticipate and intervene in deficit conceptions of families as well as design for and cultivate liberatory conceptions (knowing that they will likely emerge simultaneously, and in a complex ecology of meaning that has historical roots) is critical to envisioning and enacting educational justice.

In the remainder of this paper, I examine all community design circles across the 10 Design Collaboratives to articulate the conceptual ecologies that emerge across time and space and how these conceptions become arranged and stabilized in relation to desettling expectations and practices of families engaged in education. This analysis aims to inform how we might design for desettling family engagement across formal and informal learning environments in ways that can anticipate and reckon with tensions, contradictions, and powered dynamics.

2.3. METHODOLOGY

2.3.1. *Design Methods*

As previously discussed, this paper presents findings from an analysis of co-design data collected as part of a national participatory design research project (PDR) (Bang & Vossoughi, 2016), the Family Leadership Design Collaborative (FLDC) (Ishimaru & Bang, 2016; Ishimaru et al., 2018). In this project, we leveraged an innovative practice of participatory design research, solidarity-driven co-design, which seeks to enact PDR principles of attending to power, critical historicity and relationality (Bang & Vossoughi, 2016) in the *process* of partnering and designing with families (Family Leadership Design Collaborative, 2017; Ishimaru et al., 2018). This paper focuses on Phase 1 of the project, in which we collaborated with 10 community partners across the United States, called Design Collaboratives (**Appendix 2A**). Each Design Collaborative held between three and four design circles.

Design circles are a practice of co-design that emerges from community-based design research (Bang et al., 2010, 2014, 2016) and Indigenous methodologies (Kovach, 2012; Smith, 2013) as processes of collaboration that "engage stories, experiences, and expertise within our communities in order to

catalyze action within a particular context" (Ishimaru et al., 2018, p. 45). Integrally, these community design circles sought to expand subject-subject relations by inviting individuals with varied roles and expertise in educational changemaking (i.e., formal school administrators, families, community members, etc. and thereby also expanding definitions of educational justice and community wellbeing as emergent from these varied perspectives). Design Collaboratives were facilitated by a community member and a local researcher.

Each design circle was approximately 1.5 - 4 hours in length and audio/video recorded then transcribed. All translation of audio/video into English was conducted by individuals familiar with the Design Collaboratives, their context, and nuances of meaning. Between each design circle in each Collaborative, facilitators met virtually with the FLDC research team to analyze and reflect on emergent themes and relational dynamics occurring in the design circle. Length between design circles ranged from one week to a month.

2.3.2. *Data Analyzed*

Data were analyzed from a secondary dataset of coded excerpts and analytic memos generated from 35 design circle transcripts across all Design Collaboratives. Analysis has been conducted on design circle data, including a robust conceptual analysis of the themes around educational justice and community wellbeing that included four iterative rounds of sensemaking, coding, sensemaking of preliminary findings, and refined coding (Ishimaru et al., in prep.). All qualitative data (transcripts) were transformed into quantitative data through segmentation (Chi, 1997). Each segment reflected a single conceptual idea, sometimes negotiated from multiple viewpoints (more than one speaker) and at other times by a single perspective (one speaker), and so often included multiple turns of talk. Segmentation occurred iteratively by a team of researchers until agreement was reached. All segments (excerpts) were coded in Dedoose Qualitative software using a coding scheme developed by the FLDC research team.

To create the secondary dataset, I began by reviewing current project coding schemes and coding memos for potential overlap of codes that may inform the analysis. For example, we coded for talk about "childrearing and parenting practices" (127 excerpts across 25 design circle transcripts). This was one

large set of excerpts that includes conceptions about families and their role in raising and educating children, advocating for educational change, and partnering with local stakeholders. Review of the previous analysis yielded a subset of 26 thematic codes highlighting potential conceptions of families and their role in educational changemaking. A secondary dataset was created in Dedoose selecting only these 26 codes, generating 974 previously coded excerpts (out of 1430 possible excerpts).

2.3.3. *Analytic Methods*

I conducted a micro-longitudinal discourse analysis (DiLiema et al., 2015) on this secondary dataset to generate a conceptual ecology (Kelly & Green, 1998; Montaño Nolan, 2019) across all 10 Collaboratives as well as individual site ecologies. *Micro longitudinal* in this analysis involved investigating the sequential and temporal nature of collaborative design that occurred over the 3-4 design circles. I generated a semi-grounded coding scheme of conceptions about families from reviewing thematically coded excerpts, analytic memos, conversation with the research team, and from the literature review of family engagement (i.e., tropes, cultures, scripts, etc.). Codes were iteratively refined during the coding and analysis process as new conceptions emerged (see **Table 2-1,** emergent codes in grey). Codes are mutually inclusive to better understand co-occurrences. Secondary data were coded in Dedoose using this coding scheme. I kept a running log of themes emerging from the coding and analysis process. I also produced frequency charts of conceptions across the data set to help me see patterns and variations over time and across contexts. I then clustered particular conceptions into larger coordinating classes to better understand the conceptual ecology across the entire data set as well as within particular design Collaborative contexts. I used code excerpts and analytic memos to cross-reference emerging claims from the data.

Table 2-1 Code scheme and applied code count for conceptions of families engaged in educational changemaking

Code	Definition	Code Count
Advocates	Some families fight for the educational rights of their child(ren), recognizing that education is not equal or equitable	64
Bad parents	Some families are apathetic or abusive to their child(ren), and/or are barriers to their child's academic and life success	29
Beneficiaries	Some families benefit from school and the resources (academic, social, etc. that schools and other educational institutions provide	43
Caring/ high academic expectations	Some families have high educational expectations and care about the academic achievement and educational opportunities of their child(ren)	26
Choosers	Some families navigate educational systems to select the best opportunities for their child(ren)	14
Critique of the bad parent	Some families are often conceived as bad parents, but this inadequately characterizes their role and relationships with their child(ren)	39
Decision-makers	Some families are in positions to make decisions that impact their child and other children in educational systems	17
Dreamers	Some families envision alternative forms of education than current dominant or mainstream forms	13
Hard to reach	Some families are difficult to bring into schools or other educational institutions	5
Intimidated/ excluded	Some families are purposefully intimidated or excluded from educational institutions as a form of oppression	21
Knowledgeable of the issues	Some families are intimately aware of and critical of the issues impacting educational justice or community wellbeing	4
Learners	Some families are learning more about navigating educational systems or changemaking processes	36
Partners in schooling	Some families are partners with educators, school admin, etc. in the education of their child(ren)	54
Resistant/ protective	Some families resist institutional pressures and protect their child(ren) from institutional harm	21
Socializers/ educators	Some families educate and socialize their child(ren) into cultural/communal life	96

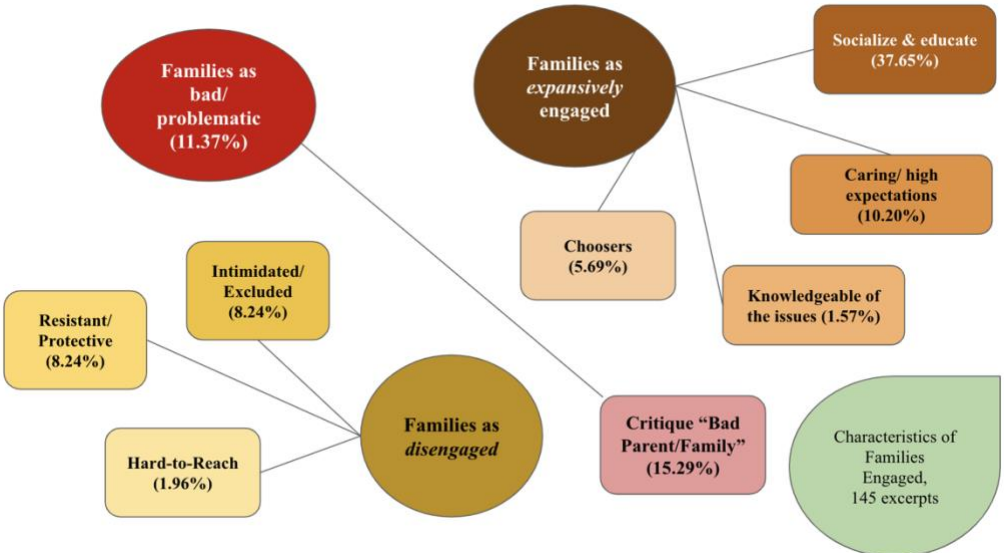
Notes. Emergent codes in grey. Code count represents the number of total excerpts across entire secondary data set. Not all excerpts in secondary data set pertained to families, or contained a conception of families engaged in education. Total number of coded excerpts was 388.

2.4. FINDINGS

2.4.1. *Characteristics of Families Engaged in Education Refract Divisive Paradigms*

Co-designers across the Design Collaboratives narrated conceptions of families that describe the characteristics or attributes of families who are engaged (or not) in education. These conceptions were particularly focused on defining, and at times expanding, the *who* of educational engagement. These include eight conceptions about families that I organize around three main coordinating classes: (a) families are bad/problematic and critiques of this conception; (b) families are *dis*engaged from school-based forms of engagement; and (c) families are expansively engaged in education across formal/informal settings. **Figure 2-2** illustrates how these conceptions hang-together in their coordinating classes, particularly around disrupting and expanding the conception of families as bad or problematic. Further, the proportion of each characteristic conception in relation to the total across all Design Collaboratives is represented in the figure. To unpack these coordinating classes I first describe the arrangement of conceptions across all Design Collaboratives. Secondly, I examine variations within particular Design Collaboratives in conceptual ecologies around these coordinating classes.

Figure 2-2 *Diagram of characteristic conceptions of families engaged, arranged in coordinating classes*



Note. Rectangles represent conceptions of families. Circles represent coordinating classes. Lines represent connections between conceptions and coordinating classes. In this diagram, the coordinating class of families as "bad/problematic" cuts across the coordinating classes of families as expansively engaged and families *dis*engaged, as these are kinds of implicit critiques.

Conceptions of Good/Bad Families. The conception of families as bad or problematic represents 11% of all characteristic conceptions discussed across the design collaboratives, with an additional nearly 16% of conceptions explicitly critiquing this "bad family" conception. As noted earlier, the conceptions of families as bad/problematic are well-worn assumptions that undergird deficit framings of families as barriers to children's academic and life success (e.g., Baquedano-López et al., 2013; Ishimaru & Takahashi, 2017; Wilson Cooper, 2009). These assumptions are well documented in the field and my analysis corresponds with these studies. Critiques largely were direct confrontations about settled assumptions – often framed as preconceived judgments – of families as apathetic, irresponsible, or barriers to child success in schools or life. These critiques often took the form of personal reflection as individuals shared how they have been judged for their non-engagement in sanctioned ways or know of other families who are similarly judged. For example, we see in the following excerpt one facilitator, Ms. Rodriguez summarizes the collective feeling of discontent as co-designers - white and Latinx mothers with children in the public school system - shared their reflections on who gets "judged" as being a good or bad parent.

1 There is judgment from the school board, then there's judgment from the principals and the
2 superintendent and sometimes teachers and judgment from parents, like parents judging one
3 another. What's a good parent, what's a bad parent. This parent doesn't do this, this parent does
4 that. How do we start breaking that up, that judgment? (Ms. Rodriguez, Design Collaborative #1,
5 design circle 3 transcript.

In lines 3-4, Ms. Rodriguez, a Dominican immigrant, mother, and university researcher, highlighted how this judgement is not only initiated by schools, but also by families as they create false dichotomies of their own "good" characteristics in relation to the "bad" families. This direct challenge was in response to the deficit conceptions of families, in this case immigrant, English-language learning families in the school district, who were perceived as non-engaged because they were not physically present at schools or perceived as problematic because they advocated for additional resources from the school (i.e., translation/transcription, instructional aides, etc.). Ms. Rodriguez went on in this design circle

to share how she too is often judged as an immigrant, bilingual, working mother - and feels judged by the co-designers in the room - for her perceived non-engagement. I return to this theme of binary positionalities in the discussion of this section and in the next finding section.

The coordinating classes of families expansively engaged and *dis*engaged are implicit critiques of the good/bad family dynamic. These are related to what Ishimaru and colleagues (2019, in prep.) refer to as complementary theories of change that simultaneously seek to expand what counts as family engagement by (a) recognizing and honoring how families are engaged in non-school sanctioned ways; and (b) critiquing the inequitable dynamics that play out when families, particularly nondominant families, do engage in schools.

Families are Expansively Engaged. The coordinating class, *families are expansively engaged,* is made up of several conceptions that define when and how families do engage in educating their young people in familial and communal contexts. The largest conception was families as socializers and educators and made up more than ⅓ of all characteristic conceptions. These framed families as role models and facilitators who support children in their cultural identity development and socialize them into participation in their communal life (Rogoff, 2003; Gutiérrez & Rogoff, 2003). Families were also conceptualized as caring about (Wilson Cooper, 2009) and having high academic expectations for their children and, in many cases, other children in their communities across grades and schools (10.20% of characteristic conceptions). These high expectations were complementary to the ways families were narrating their own roles as educators. In other words, as families critiqued deficit conceptions of themselves as "uncaring," they also challenged deficit conceptions of their children rooted in assumptions about young people that are similarly raced, classed, gendered, etc. Families were also conceptualized as knowledgeable of the kinds of issues in their communities, and therefore their voice was necessary to theorizing and designing solutions. Finally, families were conceived as intentionally making choices about how their children would be educated, including what schools they would attend and the kinds of advocacy they were willing to engage in (5.69% of characteristic conceptions). While Baquedano-López and colleagues (2013) contend that in policy discourse this plays out as neoliberalism to promote

individualism, consumerism, and competition between families, I also found that many families' choices were about protecting their child from systemic oppression, which I exemplify in an excerpt further in this paper.

***Families as* Dis*Engaged*.** The coordinating class, *families are* dis*engaged*, was made up of conceptions that recognized families' choices to not engage in school-based ways. These included conceptions of families as purposefully intimidated when they enter school through English-language only policies, unwelcoming environments, and "judgement" based in stereotypes (8.24% of conceptions). Additionally, families were conceptualized as resistant to school-based interventions and protective of their children, and cultural knowledges and practices in the face of assimilatory demands. Finally, some families were conceptualized as "hard-to-reach" by schools and school-based actors due to their undocumented or refugee status, or because of their "busy" work lives (1.96% of conceptions about characteristics).

These conceptions were often overlapping as co-designers theorized local barriers to educational justice and community wellbeing. To illustrate these conceptions I present an excerpt from the second community design circle in an urban, historically middle-class African American community in Michigan (Design Collaborative #10, refer to **Appendix 2A**). This Collaborative brought together family members and school administrators to build what the facilitator termed the shift from "positionship" where families and school personnel hold oppositional and transactional positions to a "relationship" built around the notion of collective care and kinship (Design Collaborative #10, design circle 1 transcript). In this second design circle, the facilitator asked families to share their concerns and hopes around feelings of trust and safety in the schools. One family member responded. Ms. Nora is a Nigerian immigrant, middle-class mother working in the tech industry. Ms. Nora, at the time of the design circles, had two daughters in elementary school and a son about to enter Kindergarten. She responded to this prompt with her personal decision to remain in the school district of Design Collaborative #10, despite socio-economic opportunities to move to neighboring communities, presumably with access to differential opportunities for academics and economic mobility. This choice came from the knowledge about how young black men

are perceived and treated in schools gleaned from her own experience with other families and in her read of broader socio-political movements across the nation.

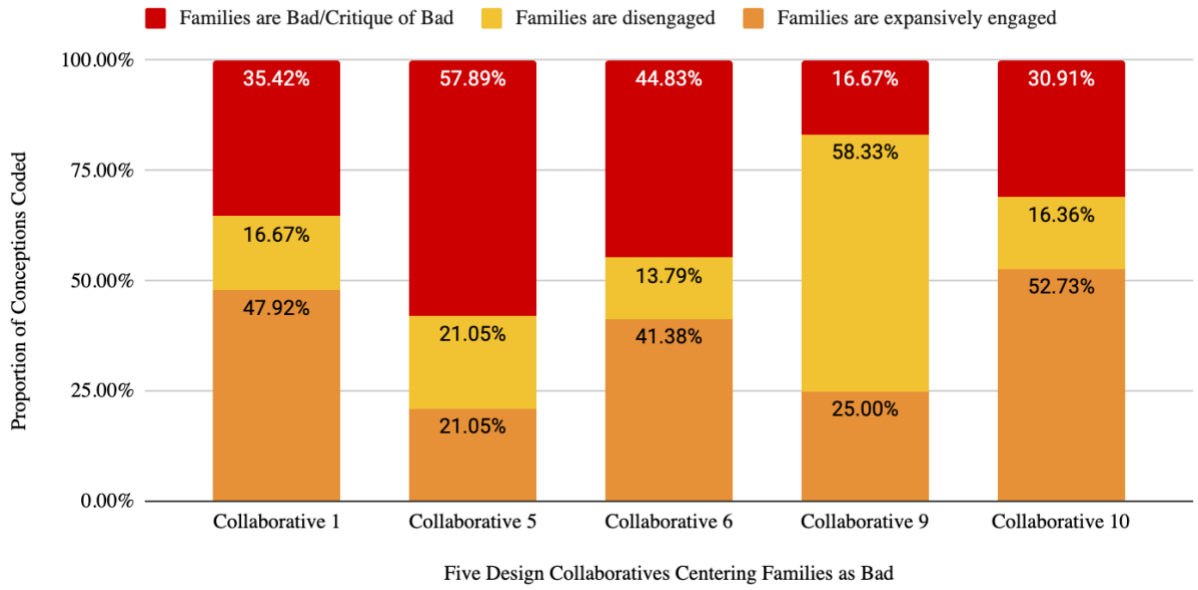
Excerpt from Ms. Nora (Design Collaborative #10, design circle 10 transcript)	**"Conceptions of families" code**
I have made purposeful decisions in [this community]. My coworkers, a lot of them live in [neighboring communities]... and they ask me, 'Why don't you live out there?' And I said, 'No.'	Chooser
Because one time I was really honest I said, "I have black kids. I need them to go to a school where somebody's not going to be calling me all the time and suspending my child." I need you [school administrators] to give [my kids] a chance, and especially me having a son and me being like, I read. I'm cognizant of life with black boys. Sometimes [black boys] get kicked out and I was like, "No, no, no. We're not going to have that."	Resistant/protective Knowledgeable of the issues
I would've sued somebody or gotten in trouble. No.	Resistant/protective
I need for [my sons] to stay in [in this community] because, I figured, because of the demographic and how the teachers [are racially similar]... you're not just going to kick my son out. You're at least going to give my kid a chance and we're going to work this out before you do anything drastic.	Chooser Knowledgeable of the issues Caring/ high expectations
In terms of feeling safe, right? And I have friends where their son went to [another school] and it was just ... his experience, I was horrified. He's like, "I'm always the black kid that have to explain everything." And I was like, 'Oh no, we're not having that. You don't have to explain yourself. You don't have to answer for anybody.' So it's just that whole safety and feeling safe. Not just like [physically] safe.	Resistant/protective Socializer/educator

In this brief excerpt, Ms. Nora leveraged three interrelated conceptions of families that expands how she conceived of herself as engaging in the education of her child by being vigilant of the way systemic, anti-Black racism manifests in school-based settings, as well as countering why she may be conceived as a problematic parent ("I would've sued somebody or gotten in trouble"). Throughout the excerpt Ms. Nora emphasized "you" to the school administrators, urging them to perceive her as she conceived of herself, as a knowledgeable mother who actively cares about and makes intentional decisions for her children and their education. Further, she articulated her desire for a partnership with

school administrators that respected her child (in this instance I believe she is referring explicitly to her son) “You're at least going to give my kid a chance,” and respected her position as mother “and we're going to work this out before you do anything drastic.” In her final lines she argued that safety in a school context extends beyond physical safety, as other family members had been previously narrating, but also to their social-emotional wellbeing as tied to their racialized identities.

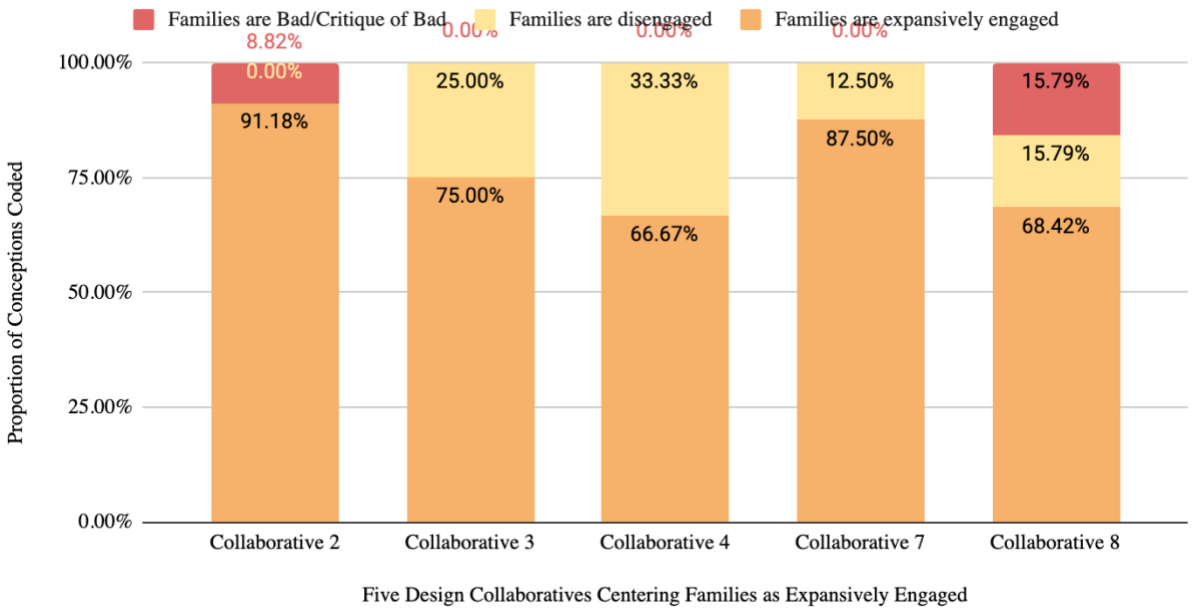
There were important variations across Design Collaboratives as to the extent that conceptions of bad families explicitly or implicitly were centered in theories of educational justice and community wellbeing. These differences are visualized in Figures 2-3 and 2-4 as I present the proportion of each coordinating class (not broken down by conception) across each Design Collaborative. In **Figure 2-3**, five Design Collaboratives were identified where conceptions of families as bad were centered in collective discourse (both the assertion that they are bad and the critique that they are not). Meaning that nearly 50% or greater of their conceptions were about families as bad, problematic, or disengaged because of the negative conceptions and practices of schools (red and yellow proportions in the bar graph). In three of these Design Collaboratives (5, 9, and 10), educators or school-based administrators were co-designers present in these design spaces. In the other two Collaboratives (1 and 6) only families and education researchers were co-designers; suggesting that roles in formal institutions did not solely play a factor in how these deficit conceptions unfurled. These Design Collaboratives all included explicit attention to repairing school-based engagement in their design objectives. I argue that by centering theories of justice and wellbeing around school-based repair, the ecology of conceptions in these Design Collaboratives were saturated in settled conceptions and the desire to *de*settle these through counter evidence and critical analysis.

Figure 2-3 *Frequency chart of conceptual ecologies for Design Collaboratives centering families as bad*



In contrast, I identified five Design Collaboratives where conceptions of families as expansively engaged were centered in theories of educational justice and community wellbeing, with well over 50% of conceptions focusing on what families do to educate and care for their own children and the children in their communities (**Figure 2-4**). In each of these Design Collaboratives schools and school-based relationships were not the focus of repair. Indeed, each of these Design Collaboratives began their first design circles by articulating how educational justice can/does/should contribute to their familial and community wellbeing and identifying the communal resources that already exist that could be amplified or reclaimed. In three Design Collaboratives (3, 5, & 7), the conceptions of good/bad parents did not emerge as part of the collective sensemaking around educational injustice. In Design Collaboratives 3 and 5, co-designers narrated broader socio-political forces of assimilation, anti-immigrantism, and political exclusion as systemic (in)justices that also manifest in school relations. In Design Collaborative 7, the focus was on addressing political levers for social changemaking.

Figure 2-4 *Frequency chart of conceptual ecologies for Design Collaboratives centering families as expansively engaged*



These data demonstrate two key dimensions of how power, critical historicity, and relationality operate in our co-design spaces when we centralize theories of educational (in)justice and community wellbeing. First, families' relationships within institutional contexts are steeped in powered dynamics that are replicated in how co-designers imagined and dreamt anew possibilities for systemic repair. These conceptions were inserted, negotiated, and contested in public discourse in ways that opened space for critical awareness of problematic dynamics - that is, they did not remain settled or stabilized. As exemplified in Ms. Rodriguez' statement about feeling judgement from school-based actors *and* other families, these conceptions are often the entry point for many families into engagement with educational systems. And as exemplified in Ms. Nora's critical reflection on her potential interactions with other schools, many families have developed a reflexive critique of the "bad parent" dynamic and urge school-based actors to perceive them and their actions in positive ways. Secondly, undergirding these conceptions were notions about agency - who gets to define themselves as "engaged" and whose engagement transforms systems of education towards their community-defined justice and wellbeing. I

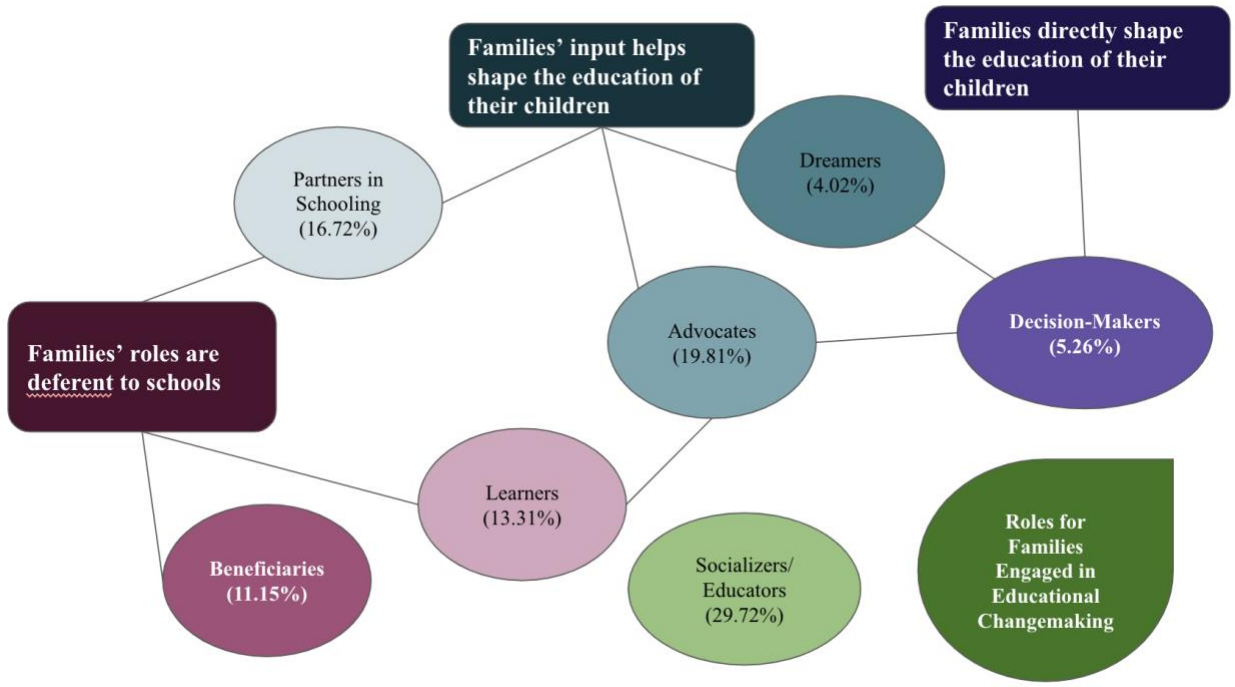
take this up more explicitly in the following finding section where I unpack the varied conceptions about *roles* for families in educational changemaking.

2.4.2. *Roles for Families Engaged in Educational Changemaking as Forms of Transformative Agency*

In addition to the conceptions of family-engaged characteristics, I also found that co-designers conceptualized the roles of families in education, including seven conceptions organized around three broader classes. **Figure 2-5** illustrates how these conceptions are arranged within their broader classes, including (a) families' roles are deferent to schools; (b) families' roles are to give input to shaping the education of children; (c) families' roles directly shape the education of children; and (d) families' roles are socializers and educators of children outside of formal educational institutions. These conceptions were interconnected and shaped by perceptions of familial agency in changemaking. I begin by describing each of these three coordinating classes, then highlight variations within Design Collaboratives. In particular, I trace the notion of transformative agency (Bang & Vossoughi, 2016; Booker & Goldman, 2016; Engeström, 2011) as pivotal to how co-designers conceptualized roles for families.

Drawing from theories of expansive learning and social changemaking, transformative agency is the possibility for individuals to envision and "breakaway from pre-existing patterns of activity" and that these emergent transformations often lead into the "unknown and unpredictable" (Engeström, 2011, pp. 611, 622). A central objective of the FLDC project, through solidarity driven co-design, was to expand the agentic role of families in transforming systems of education (Ishimaru et al., 2018). Through the following analysis, I trace how transformative agency was conceptualized within these roles for families engaged in education and educational changemaking.

Figure 2-5 *Diagram of conceptions of families' roles in education and educational changemaking, arranged in coordinating classes*



Note. Circles represent conceptions of families. Rectangles represent coordinating classes. Lines represent connections between conceptions and coordinating classes. Proportions for each conception across the entire data set are in parentheses.

The roles I describe here are specific to the roles of families engaged in shaping and potentially transforming formal systems of education; however, community specific roles for transforming social and communal systems towards wellbeing were also raised and localized to each Design Collaborative. For example, not discussed in depth here, intertribal community leaders and families of Design Collaborative #2 focused on expanding roles for intergenerational learning and collective continuance (Whyte, 2013) as part of broader goals to build solidarity within and across the urban Indigenous community. I briefly return to conceptions of families as socializers and educators in their own communities (also a characteristic conception) to exemplify how co-designers positioned transformative agency outside of institutional spheres.

Families' Roles: Defer to School. Similar to critiques in the field of family engagement, some roles for families were conceptualized as deferent to school-based agendas, knowledges, and practices. Most explicitly, two conceptions emerged in design circles: families as learners and families as beneficiaries. While there were conceptions of families needing to learn how to better prepare their child(ren) for school success (as exemplified in Ms. Thomas' description of young parents), more often co-designers in Design Collaboratives conceived of families as (a) learning how to navigate school based systems in order to know how to appropriately advocate for change; (b) learning how to help their child develop resilience in the face of assimilation and systemic racism; and (c) learning how to support and connect with one another across roles and cultural communities. For this reason, in **Figure 2-5**, the conception "families as learners" is connected to both "families as advocates" and "families as socializers and educators." I argue that when conceptualized around advocacy and socialization practices, the conception of family as learners expanded agency for families to draw upon their familial and communal resources to shape what and how culturally thriving learning could unfold in formal and informal learning environments. However, such agency was couched within incremental school change - as families learned the necessary skills to either adapt or protect their child they might be able to transform aspects of the system.

The conception of families as beneficiaries highlighted how families, especially and almost exclusively immigrant English language learning families (notable exception Design Collaborative #5 as discussed earlier) benefit from school-based programs that acculturate and assimilate them into U.S. culture (11.15% of role conceptions) or aid in the academic achievement of their children. This conception had both positive and negative valence. For example, some families conceived of their role as *deserving* of support from schools - that these were public services that ought to provide familial and community resources for community wellbeing (i.e., wraparound services, language classes, advocacy training, etc.) as well as educational justice (i.e., resources on navigating U.S. systems, translation and transcription services, afterschool programming for youth, etc.). In other words, their role as beneficiaries was based in notions of schooling as a public good that they were entitled to and sometimes emerged

alongside conceptions of families as advocates, or learning to be advocates for these benefits. This conceptualization also led to rifts between families as they competed for "limited" resources and inclusion to programs for the benefit of their individual children, and relied on conceptions of "bad families" to argue why some families (and their children) were deserving of these limited resources and others were not. This typically occurred along racialized and linguistic lines as schools differently offered resources based on demographic "needs" as well as prominent advocacy groups in the schools. In this conception, families were non-agentic in their relationship with educational systems.

***Families' Roles: Give Input to Shape the Education of Children*.** Families' roles were also conceptualized around the notion of reframing expertise in partnership with - and advocacy towards systemic change (Ishimaru & Takahashi, 2017). In other words, families were often characterized as knowledgeable of the issues in educational (in)justice as well experts in their own cultural knowledges and practices and therefore necessary to shaping educational decisions. Roles were conceptualized along three dimensions: families are partners in schooling, families are advocates, and families are dreamers. Most expansively, the conception of families as partners in schooling took up the notion that family "voice" is necessary to making schools more just. As evidenced in Ms. Nora's demands to have herself and her children treated with respect by school administrators as they problem solve, co-designers across the Design Collaboratives desired new forms of school-family partnerships built in trust, collective care, and attention to disengaging practices based in race, class, language, etc. For example, in Design Collaborative #10 both school administrators and families reclaimed roles as aunties and uncles in shared care of raising whole, healthy young Black children and their families. In the following quote, Ms. Dinah, an African American elementary school principal said,

> It does more for expanding your village. It does more for empathy and understanding. It does more for understanding your own child and your role as a parent when you don't feel like you're on that island and when you're not looking at everybody as if, "Oh, it's me and my child against them." How do we facilitate these types of conversations? […] So, how do we build that foundation for families and parents, to be. Just to be. To be more whole and their kids to be more

whole. (Ms. Dinah, elementary school principal, Design Collaborative #10, design circle 3 transcript)

The notion partnership for the purpose of raising whole and healthy children and families permeated across Design Collaboratives in ways that intended to re-mediate the historical dynamics of schooling and school-family "partnerships" as a force for assimilation (DCs 2 & 3), forced removal of children (DC 2, 5, 8), and intergenerational fracturing (DC 2 & 9). In Design Collaborative #6, the design objective was to explicitly examine and re-imagine family-educator relationships towards ending disproportionate pushout and discipline of young people, primarily young Black boys. As the facilitator of this Design Collaborative put it, "we cannot love, the school cannot love the kids and hate the parents. And that's everybody. That's all of society, actually." (Ms. Daisy, executive director of non-profit organization, Asian American, Design Collaborative #6, design circle 1 transcript)

Families were also conceptualized as advocates for educational change, often in binary relation to perceived and experienced change-resistance from schools. In other words, families often perceived more agency in changing the system from the outside, utilizing communal forms of empowerment and changemaking, than in partnership with schools (Mediratta et al., 2009; Shirley, 1997; Warren et al., 2011; Warren et al., 2016). For example, Design Collaboratives 4, 5, and 8 explicitly identified the need for grassroots pressure on elected officials across different governmental agencies to transform educational systems to reflect the needs of communities. Additionally, Design Collaborative 6 identified intercultural organizations and political figures who might stand in solidarity against all forms of oppression - patriarchy, fascism, cultural genocide, Islamophobia, and racism as a way to address the rise of white supremacy occurring in schools post-Trump election.

Finally, families were also conceived as dreamers who can and should envision alternative forms of education. This conception most explicitly took up the notion that expansive agency should lead into the "unpredictable and unknown" (Engeström, 2011, p. 622). I argue that the community design circles *enacted* this conception that co-designers are also dreamers who can and should engage in "creative, deliberate, and consequential" changemaking (Bang et al., 2016 p. 28). However, this conception was less

often extended to consider the role of families outside of the design space. Emerging analysis of phase 2 of the FLDC in which we engaged deeply with five Design Collaboratives suggests that this conception of families may have been more explicitly taken up and expanded in this second round of co-design.

Families' Roles: Decision-Makers. Families were also conceptualized as decision-makers in formal school spaces. These roles were largely aspirational conceptions as there were few instances of co-designers identifying spaces where nondominant families currently hold decision-making agency in schools (i.e., the conception of white, middle-class, mothers running the PTA was widely critiqued as a problematic form of decision-making). Design Collaborative #9 focused explicitly on re-mediating the school community council - a decision-making body within the schools - towards community definitions and processes for decision-making. Further, co-designers centralized the need for increased representation from nondominant families on this decision-making body, and as such sought to examine how families are currently *dis*engaged in the council.

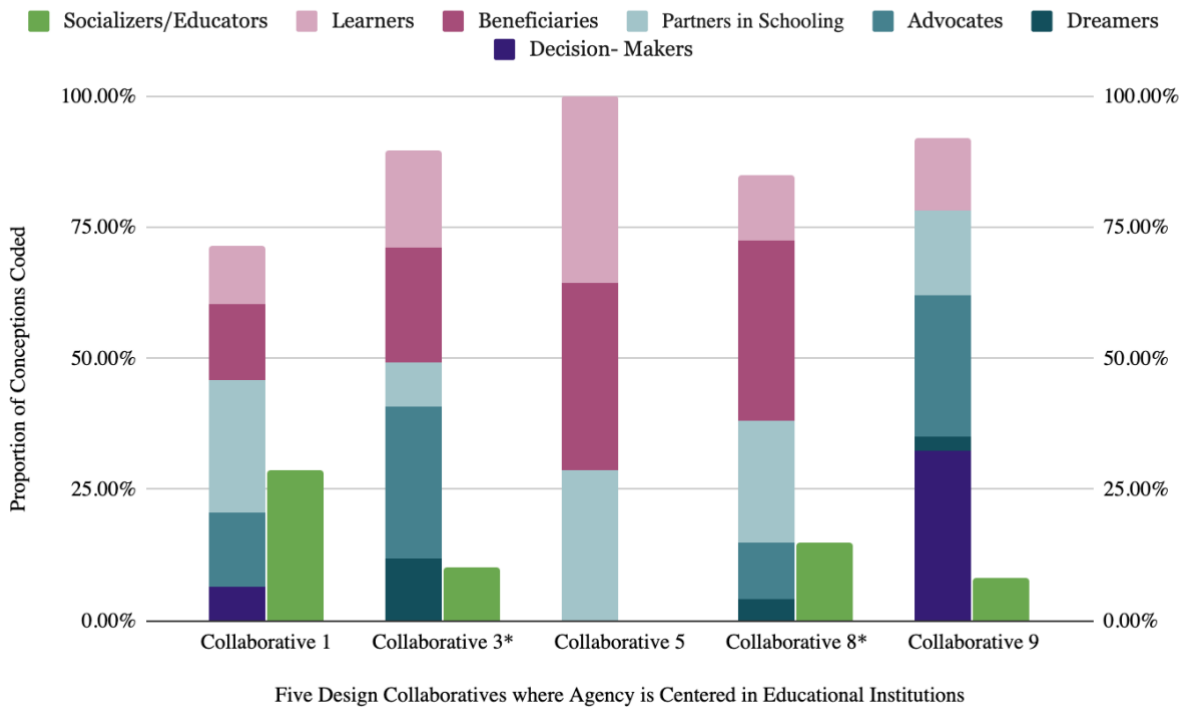
In tracing transformative agency across these conceptions and coordinating classes, I found that agency was often conceived as either centralized in educational systems or in families and communities - outside of educational institutions. This is visualized in **Figures 2-6** and **2-7**. In these charts I present a proportion of these conceptions within each Design Collaborative. Additionally, characteristics of families engaged in the socialization and education of young people was included in this proportion for two reasons. First, many families conceptualized the education and socialization of their young people as a vital role that they play. For example one African American mother of children in elementary school in Design Collaborative #10 said,

> I mean, I wish I could really express to you all, outside of the tears, what it really feels like to me on the inside when I think about [being a mother]. I don't have the words to explain it. This is one of the greatest and the hardest things I will ever have to do, and that's being a mother. And I take it very seriously. I don't take it lightly, I don't take it for granted, because God has put me in this position. And then what I always think is, "What is my purpose in this role?" Is it just for my kids, it couldn't be because I'm sitting here at a table with all of you, so it has to be more for

[more] than just my kids. It has to be more than that. And so, again, if I can be a catalyst of change, that will make all of this better, for everybody else. (Ms. Olive, Design Collaborative #10, design circle 4 transcript).

Secondly, as exemplified in the shift in proportion of socializers/educators conception (i.e., green bars) between **Figure 2-6** and **2-7**, some Design Collaboratives centrally positioned agency within the roles of families and communities and outside of schools or formal educational institutions.

Figure 2-6 *Frequency chart of conceptual ecologies centering school-based repair*



Note. Proportions of conceptions total 100% in each Design Collaborative. The conception "socializers/educators" is in the right vertical axis to indicate that the conception was present in the conceptual ecology but the role was conceptualized outside of educational institutions (left axis column).
*Asterisk next to Collaborative names refers to the Design Collaboratives where characteristics of families as expansively engaged were centered (i.e., Figure 2-4).

Illustrated in this Figure 2-6, five of the Design Collaboratives conceptualized the agentic role of families as giving input to educational change and directly shaping educational decisions. These collaboratives also conceptualized families as non-agentic beneficiaries of schools - both through learning how to navigate and advocate for change (potentially agentic), as well as receiving social services within

the school (non-agentic). Familial roles as socializers and educators made up less than 15% of the conceptual ecologies in Design Collaboratives 3, 5, 8, and 9 and less than ⅓ of conceptions in Design Collaborative 1. In other words, the conceptual ecology of these Collaboratives revolved around unpacking how educational systems decide who (characteristics of families) should shape educational systems and expanding what sanctioned roles might be in this process.

This is exemplified in the excerpt from Design Collaborative #9 below where Ms. González described the potential transformative role of families in the school as well as the ways schools reinforce familial fracturing. Ms. González, a bilingual Mexican-American, held a formal position as a school-community liaison within the district. As she described the possibility for families to directly have a "voice" in education, she also spoke from her position as simultaneously a community member in the Latinx community and a staff member of the school district. Her toggling between pronouns "I" and "we" exemplifies this dynamic. When she used "I" she spoke from her position as a school liaison who connects families to resources within the school and advocates with them when issues arise. She used "we" when speaking from both of her roles to open space for the voices of her community in her schools. Further, she leveraged conceptions about the characteristics of families in her discourse.

Excerpt from Design Collaborative #9, design circle 1 transcript	**Conceptions of roles [characteristics of families in brackets]**
The [school community council is] an opportunity. I see it as engaging the community to teach them that no matter where they go, they can have a voice.	Learners Advocates
Most importantly, I think it's that relationship with the children because in the long term, right now we are obviously ... There's horrendous things that are happening in our cities, in our states, in our world. Sometimes, we have positions where we can see seriously broken families. From whatever reason, so many instances of deportation, gangs, school failure.	[Bad families, if unintentional]
"I just got here from Mexico and I have no idea what the math teacher is talking about," so it starts to break the family.	Learners [Intimidated/excluded]
Where I would like our approach in engaging with families and asking them, "Come, come, come help us. Whatever you want to do, come help	Partners in schooling Socializers/educators

us." It's an opportunity to try to get them to engage again with their young, with their grandchildren because we have lost that so much.	

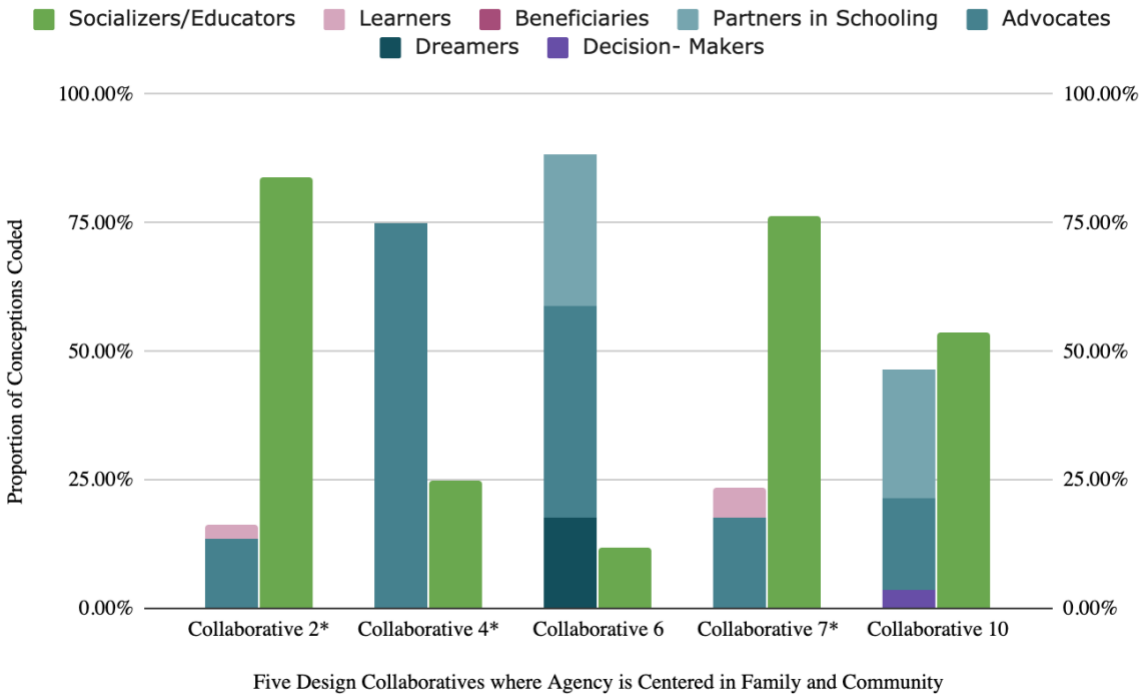
Ms. González began with a clear narration of the importance of *community* voice on the school community council - a decision-making body within each school in the district. She leveraged conceptions about families as learners in order to highlight the role that advocacy can lead to change; however she does not position schools as the center. Rather, she narrated that families have a voice "no matter where they go." In this conception, schools teach families how to advocate for their own change - again the conception of families as benefiting from school programs is implicit in this conception of families as learners. She then spoke from her position within the community and as a trusted person with the schools to identify that some kids come from "broken families." While not explicitly about "bad families" the implicit assumption is that kids need caring relationships within the school, perhaps with school staff *and* with families who are in the school, since their home lives are "broken."

She further argued that school failure plays a direct role in breaking families apart as illustrated in her example of the math teacher who, presumably, dictates to families learning objectives or discipline problems in ways that do not deal with families lived realities ("I just got here from Mexico") and inaccessible to families ("I have no idea what the math teacher is talking about"). She said "it starts to break the family." I argue here that she narrated the disempowerment that immigrant families (and many nondominant families) experience when schools minimize their inequities and exclude them from meaningful engagement. Schools become the source of both care and education in ways that generationally remove children from the knowledges and practices of their families ("We've lost that so much"). In Ms. González' solution then, schools play a fundamental role in repairing intergenerational divides and creating opportunities for families to be empowered for change - in their schools and communities. This ecology of conceptions was mirrored across the other four Design Collaboratives as they sought to expand familial agency within school-based systems, while also reckoning with the

systemic resistance to change and powered dynamics that must be transformed if families agentic roles were to be realized.

In contrast, Design Collaboratives 2, 4, 6, 7, and 10 located agency outside of school-based systems (**Figure 2-7**). These Collaboratives all occurred within community organizations and as such leveraged their power and agency outside of school systems to envision and enact educational changemaking. In Collaboratives 2, 7, and 10 the majority of agency was located in the roles that families play as educators and socializers within their own families and communities and sought to build and enhance those roles for systemic change. Collaborative 6 focused on empowering families and community members for advocacy work within school systems, while Collaborative 4 sought advocacy in local politics to enact school reform.

Figure 2-7 *Frequency chart of conceptual ecologies centering families and communities*



Note. Proportions of conceptions total 100% in each Design Collaborative. The conception "socializers/educators" is in the right vertical axis to indicate that the conception was present in the conceptual ecology but the role was conceptualized outside of educational institutions.
*Asterisk next to Collaborative names refers to the Design Collaboratives where characteristics of families as expansively engaged were centered (i.e., Figure 2-4).

2.5. CONCLUSIONS & IMPLICATIONS

A core goal of the Family Leadership Design Collaborative was to ground visions for educational justice and community wellbeing across multiple geographies and intracultural communities, organized around different *aperturas* – or opportunities for changemaking – with different configurations of relations to institutional and community power (Ishimaru & Bang, 2016). By seeding multiplicitous visions and designs for educational changemaking across places and relations, it was our hope to provide the field with place-based theories and practices grounded in the heterogenous lives of families and communities. The divergent entry points into educational changemaking identified by each Collaborative provide unique vantage points from which to expand our interpretive power (Rosebery et al., 2016) as we reached towards axio-onto-epistemological relationality in ways that do not settle into prescriptive, singular solutions. The purpose of this paper was to articulate a framework for families engaged in education that expands our ability to observe, anticipate, and intervene in conceptions about families. Through an analysis of community design circle transcripts, I demonstrated that

> (a) conceptions of families are both ideological and physical, they refracted socio-political paradigms of (injustice) and shaped possible roles for families to change systems of education;
>
> (b) conceptions of families become arranged in particular configurations over time and stabilized as a coordinating class of conceptions including both the characteristics of families-engaged as well as possible roles inside and outside of educational institutions; and
>
> (c) conceptions of families are situated and socially shared, co-constructed, and challenged as individuals make sense of what educational (in)justice and community wellbeing meant within their geographical and intercultural community – and from multiple roles within and outside of educational institutions.

In the following, I reflect on how binaries and relationality emerged across the core findings of this paper and close with potential implications for participatory design research.

2.5.1. *Reflection on Axio-Onto-Epistemological Relationality in Key Findings*

In this analysis I found two primary types of conceptions about families that characterize who is engaged and what counts as engagement; and also define roles for families to shape and potentially transform systems (or not). Within these types, I found a series of conceptions that develop, stabilize, and destabilize as co-designers theorize local definitions of educational justice and community wellbeing, and in so doing, navigate multiple roles, perspectives, and expertise on the issues and potential solutions. Each Design Collaborative developed unique conceptual ecologies, refracting who was present during co-design and the context in which they were co-designing. Importantly, the central or peripheral position of school-based systemic repair in theories of changemaking dynamically shaped the conceptions of families unfolding in public discourse. I argue that articulating the entry points of systemic transformation matters for the kinds of conceptions that are mobilized in sensemaking about the issues and potential solutions.

When healthy children and families - communal wellbeing - was centralized the conceptual ecology, co-designers conceived of families' agency outside of school systems as leverage points for changemaking. Further, as schools were not centered, the kinds of conceptions about families that pervade the racialized and ritualized scripts of schooling (i.e., families as bad, families as learners, families as beneficiaries) were nearly absent in the conceptual ecologies of these Collaboratives. Articulating the profound work of Jurow and colleagues (2016), Bang and Vossoughi (2016) contend that "forms of social change making and learning that are nurtured on the margins or in the borderlands may, at times, afford greater room for self-determined intellectual and relational activity" (p. 183).

When school-based repair was centered, deficit conceptions of families - and the critique of such conceptions - were also prevalent in sensemaking. For example, deficit conceptions of families were complexly contested from multiple vantage points as co-designers, across many Design Collaboratives, reckoned with historicized disempowerment and seemingly-immovable systems. For some Design Collaboratives, being able to grapple with the (settler)-colonial imperatives of engaging families in educational changemaking opened space for individuals (educators, educational leaders and families) to critically examine their own engagement practices as powered and historicized and to re-imagine school-

family relationships that attended to these dynamics. This included both expanding who counts as an engaged family and recognizing the systemic ways families are disengaged. Additionally, this included increased roles for families in formal learning environments to shape educational decisions. I contend this is a kind of conceptual role re-mediation that sought axiological and ontological relationality by valuing the multiple and heterogenous knowledges and practices of families that contribute to the education of young people across formal and informal learning environments. Further, by negotiating such conceptions in public discourse, these community design circles served to expand epistemological relationality. In other words, I found moments where binaries between educators and families, and between dominant and non-dominant families were conceptually desettled. At other times, both systems actors and families fell into paralyzing binaries, reproducing "straw men" families (and at times straw men educators/administrators), who served to rhetorically privilege the agency and power of those in the design space in opposition to the "bad family." Thus, I contend that role re-mediation between individuals *within* the Design Collaboratives inadvertently created opportunities for resettling deficit conceptions of those families *not physically present*. These findings suggest that co-design affords time and space for critical repair between families and educational institutions that also requires ongoing vigilance to the kinds of conceptions about families that are mobilized. I turn now to some key implications for participatory design research.

2.5.2. *Family Engaged Implications for Co-Design*

Families and communities are increasingly sought as partners for education and educational changemaking, as evidenced by the increasing number of research-practice-partnerships in education research and family-engagement partnerships in formal and informal educational institutions. There is growing recognition that families are necessary to cultivating intellectually stimulating learning environments that meaningfully connect to learners' everyday and communal lives. Yet, as discussed in the introduction to this paper, all forms of institutionally-based partnerships with families – including, and especially those of educational researchers and families/communities – are fraught with powered and historicized dynamics that shape the kinds possibilities for educational justice and community wellbeing

to unfold (or not) (e.g., Bang et al., 2016; Bang & Vossoughi, 2016; Fine et al., 2003; Gutiérrez & Vossoughi, 2016; Warren et al., 2016). And, as evidenced in the findings of this paper, our conceptions about families – as units of individual and collective thought - shape who we seek to partner with, how we enact our partnerships, and how we shift our designs in response to/with families' desire for change. This includes both the families and communities that are (a) present-partners, the individuals and collectives who "show up" to co-design or are physically present; (b) presenced-partners, the individuals and collectives who are represented and conceptualized in co-design but who may not be physically present; (c) yet-to-be presenced-partners who we are extending and building relationships with or ought to be partnering with; and (d) elsewhere-partners who deliberately cultivate solidarities and partnerships elsewhere to educational institutions.

From this analysis, I argue for expanding our "interpretive power" (Rosebery et al., 2016; Pugh et al., 2019) in participatory design research to account for the settled and desettling conceptions of families that emerge in our work. While, Rosebery and colleagues (2016) specifically speak to the socio-cultural nature of science instruction, their framing of interpretive power readily encompasses many aspects of educational relations.

> Our conceptualization of interpretive power rests on the assumption that teaching and learning are fundamentally intercultural processes... They are intercultural in the sense that in any educational encounter diverse histories, points of view, meanings, and sense-making practices come into contact as students and teachers navigate disciplinary ideas and problems. Further, this navigation takes place at powered boundaries of culture, race, class, gender, and language, which shape expectations for valued forms of disciplinary knowledge and knowing in science, as illustrated in the examples discussed above. (Rosebery et al., 2016, p. 1574)

Extending interpretive power to the findings in this paper, I argue that all design interactions are also intercultural as individuals - with different powered roles and positions - "encounter diverse histories, points of view, meanings, and sense-making practices" as families and institutional actors navigate the goal and practices of families engaged in education. Interactions, then, between families and educational

institutions are always processes of becoming that are laden with multiple values, ways of knowing, and being that unfold across time and place. Below, I articulate a growing set of design commitments that build upon the work of critical scholars in participatory research methods and explicitly addresses the conceptions that we can anticipate emerging in co-design.

Cultivating multiple, porous, and transformative roles in co-design processes enables diverse perspectives, histories, and conceptions of families to shape the design process and outcomes to better reflect the place-based nature of the PDR (Warren et al., 2020). Multiple roles, means inviting individuals with diverse formal and informal roles and forms of expertise that may yield different vantage points for shaping conceptions of families, such as family members from heterogeneous cultural communities, children and youth, young parents, elders, educators (formal and informal), administrators and staff, etc. Porous roles means creating space for individuals to bring their multiple roles and intersectional identities across institutions and community spaces. For example, this means honoring that an educator may also be a parent of a school-aged child. Transformative roles means enabling individuals to shift their participation as the design space transforms over time (e.g., shifting from peripheral to central participation, or vice versa). As multiple, porous, and transformative roles take shape in co-design spaces, this also increases the opportunities for intracultural and powered dynamics to unfold in historically normalized ways or in transformational ways. Attending to the kinds of conceptions that emerge (particularly ones that desettle or resettle normative roles for families) is necessary for transformative forms of participatory design.

Engaging in open-ended, ongoing, and collaborative processes engenders opportunities for changemaking that does not seek instantaneous or final solutions to complex systems challenges. This means that new forms of relationality can be cultivated (and repaired) over time and space and, thus, expand opportunities here-and-now solutions to here-and-then challenges (Hall, et al., 2020). Further, as individuals and collectives negotiate the conditions of educational changemaking, this may lead to generative and expansive conceptions of families engaged in education. However, such ventures into the "unknown and unpredictable" (Engeström, 2011, p. 622) can also lead individuals to rely on taken-for-

granted conceptions of families that reinforce divisive binaries or deficit ideations. Practically, this may mean charting the known or anticipated conceptions about families that historically saturate the design space. For example, in the case of school-based systemic repair – this means anticipating some conceptions of families as bad or disengaged will emerge as co-designers make sense of the root causes of (in)justice. The ongoing nature of co-design affords multiple opportunities to observe, cultivate, or interrupt the kinds of conceptions that emerge over time.

3. PAPER 2: CULTIVATING NATURE-CULTURE RELATIONS IN PLACE BASED CO-DESIGN WITH FAMILIES

3.1. INTRODUCTION

Despite numerous calls to expand what counts as rigorous science learning by engaging families and communities in education (Barton et al., 2004; Rosebery et al., 2010; Tzou et al., 2019), current school-based family engagement models tend to deficitize, invisiblize, or tokenize familial knowledges and practices as well as enact disingenuous partnership practices (Auerbach, 2010; Bang et al., 2018b; Ishimaru et al., 2018). Such powered home-school dynamics are also replicated in many research partnerships (Ishimaru et al., 2018) where epistemic authority (Booker & Goldman, 2016) and agency (Gutiérrez & Vossoughi, 2010), often remain held within traditional powered roles and practices (Ishimaru & Takahashi, 2017; Philip, Bang, & Jackson, 2017; Vakil et al., 2016). Concurrently, there are growing calls for 'desettling' science education (Bang et al., 2014; Bang & Marin, 2015; Bang et al., 2018a) and family engagement (Bang et al., 2018b; Ishimaru & Bang, 2016) towards solidarious relations and expansive learning that work to decolonize systems of education. This paper makes contributions to these equity efforts by articulating how re-orienting to places, lands, and waters in our learning designs and partnering processes might open space for new forms of relationality.

3.1.1. *Research Purpose and Questions*

This paper traces the conceptual and relational contours of our co-design efforts to re-mediate family engagement from arguably disciplinary-agnostic and place-abstracted forms of partnership, towards collaboratively expanding opportunities for science learning that intimately knit our social and ecological possibilities across homes and communities locally and globally. The study described in this paper was part of an NSF-funded project, *Learning in Places*, which seeks to "co-design innovative research and practice with educators, families, and community partners that cultivates equitable, culturally based, socio-ecological systems learning and sustainable decision-making utilizing 'field-based' science education in outdoor places, including gardens, for children in Kindergarten to 3rd grade and their families" (Bang et al., in prep.). Learning in Places [LiP] draws upon theoretical and

methodological innovations in design based research, community and participatory design research, social design experiments, and formative interventions to design activities and interconnected systems of activity towards expansive learning and transformative socio-educational changemaking (Nasir & Hand, 2006).

My research questions for this paper are:

1. *How can place-based co-design expand roles for and conceptions of families engaged in educational changemaking for socially and ecologically just science education?*
2. *How did we design for and in what ways did nature-culture relationality manifest (or not) in our place-based co-design?*
3. *What transformative possibilities were expanded or foreclosed in our design processes?*

Through a critical analysis of co-design activity systems – focusing on our design practices – as well as how these intentions manifested in unfolding activity with families, educators, and community partners, I share some accomplishments, ongoing tensions, and possibilities for future family-engaged design endeavors.

3.2. THEORETICAL AND CONCEPTUAL FOUNDATIONS

3.2.1. *Sociocultural and Cultural Historical Activity Theories*

This study is informed by sociocultural and cultural historical activity theory. Sociocultural theory posits learning as a cultural accomplishment, achieved through shifting participation in dynamic and cultural-historically situated activities in everyday as well as informal and formal learning environments (Gutiérrez & Rogoff, 2003; Rogoff, 2003). The practices that individuals' and communities' participate in overtime "'hang together' in patterned ways - constellations - that change across history" (Rogoff et al., 2014, p. 85). Engagement in these routinized practices mediate human thought (cognition), giving rise to heterogeneous and culturally-nuanced knowledges and knowledge systems (Bang et al., 2010) – that is epistemic practices.

Activity theory focuses our design and analytic attention on expansion of the object of activity - that is the collective aim of action, rather than individual traits or knowledge (Cole & Engeström, 2007;

Engeström, 2011; Nasir & Hand, 2006). Participatory design research further articulates the need to deeply consider who is involved in our partnerships, why we partner, and where we partner (see also Ishimaru et al., 2018).

> "[W]e must take seriously the question of "Who does the design and why?" (Engeström, 2011, p. 3), suggesting that perspectives and motivation matter. The "who" and the "why" are also deeply bound up with the how and where of design, demanding a focus on process and the genesis of relations as well as the places within which they are made, live, and unfold." (Bang and Vossoughi, 2016, p. 179)

In our participatory co-design work we sought the expansion of subject-subject relations in our co-design processes and in imagining school-based family engagement in ways that would also expand the objects of design. As described earlier, both research and school-based partnerships can reify inequitably powered dynamics that position families as peripheral to, or beneficiaries of institutional learning and decision-making. We sought to shift these relational dynamics by intentionally recruiting and designing for meaningful familial and communal participation in our co-design. Part one of the findings of this paper explicitly narrates the design practices and underlying intentions for family engaged design work.

We also aimed to expand the *object* of such partnering processes to make visible the kaleidoscope of human axio-onto-epistemologies and practices therein as taking place on dynamic lands, waters and with more-than-human others. The purpose of co-design in this project was multifaceted including three interrelated strands of work: (a) the development of a field-based science model for complex socio-ecological systems learning that spans classrooms, neighborhoods, and local greenspaces, including gardens; (b) development of an equitable family engagement model that supports family and community learning and decision-making; and (c) development of a model for collaborative research partnerships with families, communities, and education systems that addresses power, historicity, and relationality in processes of partnering (Bang et al., in prep.). Across each of these dimensions were a range of family-engaged co-design objectives including the design of:

- a garden and/or outdoor learning space to expand learning beyond the classroom, leverage communal expertise in outdoor land management practices, and re-make human relationships with the natural world predicated on reciprocity and relationality;
- summer family programming to support garden and seasonal science learning as well as build community capacity for socio-ecological changemaking;
- instructional science materials and practices aligned to family life and supportive of expansive and consequential science learning in the classroom, homes, and community; and
- processes of partnership to grapple with powered and privileged dynamics, including developing anti-racist and decolonizing partnership practices.

By engaging families throughout our co-design process, we hoped to expand what counts as field-based science, equitable family engagement, and collaborative research processes. In section two of the findings, I demonstrate how engaging families in learning in places co-design activities expanded our conceptions of places, lands, and waters in family engaged learning and designing.

3.2.2. *Our Rhizome for Equity in Science Education*

Grounding our designs, we adopt the concept of a "rhizome" to trace how our core propositions for equity in science education - complex socio-ecological systems, field-based science learning, and families, communities, and culture - are rooted in and across our designs. Nature-culture relations and power and historicity cut across each of these propositions, delineating how we might anticipate and respond to inequitable learning and partnering dynamics. Like a rhizome, our core propositions grow horizontally across each aspect of our project, giving familiar shape and form to each design while also enabling new growth in unanticipated ways (Bang et al., in prep.). **Figure 3-1** illustrates how science learning and being (here depicted as a student engaged in field-based learning) is dialectically manifest in (a) families, communities, and culture; (b) complex socio-ecological sensemaking; and (c) field-based science learning, which are all shaped by nature-culture relations and power and historicity. Each of these

constructs corresponds with a series of design principles, emerging from decolonizing and justice-oriented scholarship, and refined and expanded over the course of our place-based co-design.

Figure 3-1 *Learning in places rhizome*

Our rhizome extends the concept of a 'germ cell' in formative interventions as carrying the blueprint for new forms of activity that lead to individual and social transformation (Engeström et al., 2012; Bang et al., 2016), and builds upon rhizoanalysis. Yrjo Engeström and colleagues (2012) describe four characteristics of a germ cell,

> (a) the germ cell is the smallest and simplest initial unit of a complex totality; (b) it carries in itself the foundational contradiction of the complex whole; (c) the germ cell is ubiquitous, so commonplace that it is often taken for granted and goes unnoticed; (d) the germ cell opens up a perspective for multiple applications, extensions, and future developments. (p. 289)

Our rhizome/germ cell makes visible how nature-culture relations as the smallest and simplest unit of complexity (a) ground human activity, (b) shape and are shaped by axio-onto-epistemologies, (c) reflect historicized power imbalances, (d) are organized in mental models that help us make sense of what

we observe and learn, and (e) are refracted in our learning environments (Learning in Places Collaborative, 2020a; Medin & Bang, 2014a; Bang & Marin, 2015).

Additionally, "[r]hizoanalysis transforms our focus on the interaction as a stable 'text' to be 'read' and interprets it as a constantly moving configuration that is ripe with potential for divergent movement" (Leander & Rowe, 2006 p. 435, see also Deleuze & Guattari, 1987). From this vantage point, our core propositions are viewed as always in a state of becoming in unfolding activity on dynamic places, lands, and waters. In this paper, I trace how particular relations and conceptions of families were a "constantly moving configuration" that were shaped by the conceptual landscape, and identity positioning, among other configurations. Our rhizome metaphor – building from the germ cell and rhizoanalysis – is also future oriented as "ripe with potential" and "future developments" that are always in a process of becoming. In this paper, I argue that attending to the dynamic unfolding moments of interaction as ripe for divergence from settled subject-subject and subject-object relations calls for a kind of rhizomatic vigilance that might anticipate and respond to moments of divergence and convergence.

3.2.3. *Nature-Culture Complementaries*

At the heart, we co-designed with and for nature-culture complementaries to make visible and re-mediate powered and historicized dynamics that cut across epistemic activity and home-school relationships (Bang et al., 2012; Bang et al., 2014; Bang & Marin, 2015; Medin & Bang, 2014a). Nature-culture relations is a linked construct that characterizes how nature and culture are considered entwined and mutually constituted (nature-culture relations), or separate and unequal (nature/culture divides) (e.g., Bang & Marin, 2015; Bang et al., 2012). **Figure 3-2** illustrates this concept by depicting on the left the male human over all other life forms, hierarchically organized in nature-culture divides. On the right humans (male and female) as equally part of a complex web of relations in nature-culture complementaries (LiP, 2020a; graphic originating from Lehmann, 2010).

Figure 3-2 *Diagram of nature-culture relations*

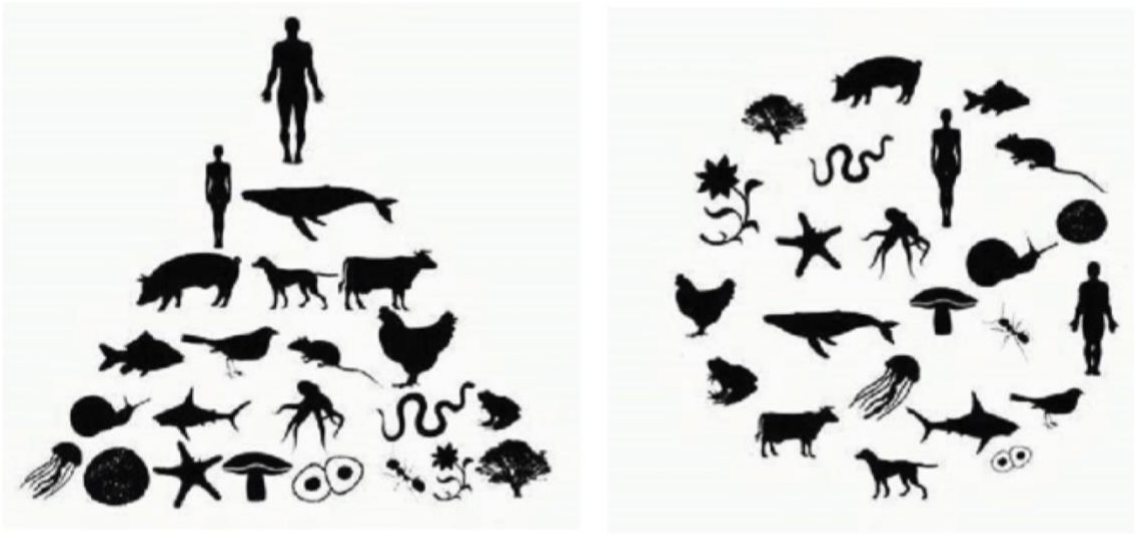


Diagram 'Ego-Eco'-Humankind is part of the ecosystem, not apart from or above it. This diagram depicts this simple fact clearly (diagram: S. Lehmann, 2010).

NATURE-CULTURE DIVIDES NATURE-CULTURE COMPLEMENTARITIES

How we construct nature-culture relations implicates how we value the particular practices of science, decisions that we make regarding socio-ecological systems, and how we might resource learning about/with phenomena in our pedagogy and practice. Many science learning environments are saturated with nature-culture divides that stymie how we conceptualize 21st century challenges and approaches to addressing them. Bang and Marin (2015) contend that divisive nature-culture constructions in science education, particularly those that hierarchize human axio-onto-epistemic dominance on/over the natural world, "restrict experienced and possible forms of agency, identities, and relations" particularly for nondominant and Indigenous students (p. 531). Further, how we construct nature-culture relations in our partnering processes shapes our proleptic politic (Bang & Vossoughi, 2016; Gutiérrez, 2008; Ishimaru et al., 2018) – or how we create the conditions in which we hope learning and changemaking can flourish (Deloria, 1979; Deloria & Wildcat, 2001). While home-school partnerships take place on lands and waters there is little regard to how such relations manifest in and shape family engagement models in school-based settings. Our designs sought to intervene in these dynamics by extending nature-culture complementaries - that is an act of reaching towards nature-culture relations and addressing nature-culture

divides - as a core construct of engaging families in co-designing school-based science education. In particular, our project sought to facilitate reciprocal nature-culture relations through designs that visiblize human interactions and decisions with the natural world as laden with cultural values, aesthetics, and powered dynamics (Bang et al., 2016; Marin & Bang, 2018), as well as collectively envision ethical decisions beyond human-harm or human-domination over others (LiP, 2020a).

The three propositions of nature-culture relations structure our possibilities for seeding family-engaged and place-based science education that is consequential to students, families, and the places on/in/with which we live. We contend that commitments to social and ecological wellbeing are necessary to address the grand challenges of the 21st century and demand a re-orientation to ethical sensemaking, deliberation, and decision-making as part of complex systems learning. Field-based science activities and practices can facilitate complex systems learning that engages students' and families' prior knowledge and connects learning indoors and outdoors in places that matter. Finally, learning and decision-making about socio-ecological systems are shaped by nature-culture relations - including the cultural identities and practices of families and communities in their everyday and intergenerational relations with places, lands, and waters. I focus this paper on nature-culture relations in family-engaged science education as holding the possibility for desettling learning and partnering.

3.3. PLACE-BASED CO-DESIGN METHODS

3.3.1. *Learning in Places: Participatory Design Research and Co-Design Orientations*

Learning in Places utilizes community-based and participatory design research to co-design opportunities for expansive science learning and partnership. Informed by design based research (e.g., Bell, 2004; Design Based Research Collaborative, 2003) and drawing explicitly upon decolonizing methodologies (Smith, 2013), community based design research seeks to advance theories of culturally mediated forms of human learning as well as the creation of learning environments that contribute to community thriving (Bang et al., 2016). Participatory design research further articulates and addresses asymmetrical and historically accumulated power dynamics within co-design processes (Bang & Vossoughi, 2016). Co-design is a practice of participatory design research that seeks to design with

families and communities rather than design *for* or *on* families (Bang & Vossoughi, 2016; Ishimaru et al., 2018). This study draws from place-based co-design as a method of place-making that foregrounds land, waters, and more-than-human others as agentic and co-determining of ethical and just futures (Bang et al., 2014; Marin & Bang, 2018; Marin et al., 2018; Pugh et al., 2019). Drawing explicitly upon decolonizing and Indigenous methodologies (Kovach, 2009; Smith, 2013; Tuck & Yang 2012), place-based co-design also works to dismantle settler-colonial nature-culture conceptions of the natural world as property or material (Bang & Marin, 2015; Barajas-López & Bang, 2018).

We engaged teams of University-based researchers, K-3 educators and families, district science specialists, and community organizations with a specialty in outdoor education in a range of place-based co-design activities. Four leadership schools and a coalition of community organizations with expertise in outdoor education participated in designing, implementing, evaluating, and revising the three strands of work described, which I reiterate here as (a) the development of a field-based science model for complex socio-ecological systems learning that spans classrooms, neighborhoods, and local greenspaces; (b) development of an equitable family engagement model that supports family and community learning and decision-making; and (c) development of a model for collaborative research partnerships with families, communities, and education systems that addresses power, historicity, and relationality in processes of partnering (Bang et al., in prep.).

Co-design teams within the schools included select K-3 educators and families within the leadership schools. Educators within each school were self-selected based on interest in improving outdoor science education, completion of district-led Next Generation Science Standards [NGSS] training, and motivation/energy for the intensity of co-design work. Families joined co-design teams either through individual invitation from participating educators or through learning about the project from flyers, informational nights, and relationship building from the core research team who attended school and community events, learned about and connected to existing family networks, etc. Some families joined co-design leadership teams as ongoing collaborators, some participated in specific co-design sessions, and others joined an afterschool program that was created to support a diversity of family

collaboration opportunities. Leadership family members received an annual stipend for their contributions to the project. Families joining for specific design sessions received a modest gift card. The core research team included a collaboration between two Universities (in the Pacific Northwest and Midwest), a nonprofit community organization with expertise in school-based garden design and education, and a local school district in the Pacific Northwest.

3.3.2. *Place-Based Co-Design Activity Systems*

Co-design occurred through a variety of formats, encouraging different forms of leadership and collaboration across our partnerships including, (a) seasonal summits; (b) monthly co-design sessions; (c) family nature-culture clubs and information nights; and (d) weekly research and design team meetings. We took an activity theory lens to design ecologies of activities (and attending participation structures, rules, roles, and mediational tools) that scaffolded towards and facilitated nature-culture complementaries across the strands of work. Design of each of these activities were driven by a series of design practices, which I discuss more in the findings section. Additionally, the research team held a series of place-based design rehearsals (Marin et al., 2018) where we walked the places of our seasonal summits to identify place-emergent phenomena, learn the histories of the place, and make relations with lands, waters, and more-than-humans. These were prevalent in preparation for the first seasonal summits held in each new location; however, we did not engage in place-design planning of summits or monthly co-design sessions at recurrent places. This represents our own (research team) slips into designing from place-abstraction and this analysis pushes us to consider how we better routinize place-designing across all aspects of our work.

Seasonal summits were one-to-five day-long gatherings with all co-design teams (described below) to design, make sense of, and iterate upon the strands of co-design work (described above). While we invited whole families, including children and extended families to these summits, we also identified specific times within the summits to focus explicitly on family-oriented design activities. As I discuss later in the paper, this was an intentional design move to create space for families to feel welcome to dream and design with us, while honoring and efficiently utilizing families' time with us.

Monthly co-design sessions were two-hour long meetings, held at each leadership school to focus on design and implementation of the storyline for each classroom, as well as inform the full design of the model. These typically focused on supporting families engaged in the project and in the storyline implementation, making sense of and designing student complex systems learning, and meeting the needs of our partners. Leadership families typically came to monthly co-design sessions at schools, but it was rare that non-leadership families would attend these design activities.

Family nature-culture clubs were monthly design and outdoor science learning sessions held at each school intended to engage in intergenerational learning with/on local lands and waters and design the outdoor learning classrooms/gardens emergent from these place-based learnings. We also held several outdoor co-design and information nights to recruit families to our project and build relationships within the schools. We also had requests by families and educators to facilitate seasonal walks in and around the schools. During these design and information nights we piloted a range of mediational tools to scaffold attention to places, lands, waters, and more-than-human others.

Weekly research/design team meetings were devoted to designing both the co-design process (i.e., content and processes of summits/design sessions) as well as the concrete activity systems of the science model. During these meetings we engaged in iterative, reflective design and redesign based on our ongoing analysis of co-design processes and storyline implementation.

3.4. ANALYTIC METHODS

This paper examines how we designed for and emergent ways that nature-culture complementaries manifested in our co-design with and for families during seasonal design summits. I focus this paper on our co-designed Seasonal Summits as these were public spaces where conceptions of and roles for families engaged in socio-ecological and educational changemaking were contested, negotiated, and expanded. We held eight seasonal summits between January 2018 and January 2020. **Table 3-1** shows each of these summits by date, duration, total number of co-designers, and number of planned activities. Reflexively, we re-designed activities in-the-moment to respond to particular dynamics as needed.

I conducted two rounds of analysis. The first focused on our design intentions regarding how families were conceptualized and engaged in the co-design process, in school-based family engagement processes, and in complex systems science learning. This analysis explicates a series of design practices centering around the notion of "rightful presencing" (Barton & Tan, 2019). The second round of analysis focused on how conceptions of families were taken up, negotiated, expanded, or constrained during unfolding activity. In particular, this second analysis traces moments where nature-culture relations were expanded and enclosed in interaction.

Table 3-1 Seasonal summit overview

Seasonal Summit	Winter 2018	Spring 2018	Fall 2018	Winter 2019	Spring 2019	Summer 2019	Fall 2019	Winter 2020
Date(s)	Th. Jan 25 M Jan 30	S. April 28	F. - Su. Oct 5 - 7	Su. - T. Jan 13-15	W. May 1	M. - Fr. July 22-25	S. Oct 19	F. Jan 10
Duration (hrs)	12 hrs	6 hrs	18 hrs	22 hrs	8 hrs	29 hrs	7.5 hrs	7.5 hrs
Number Planned Activities	16	10	22	24	11	23	4	6
Number Co-Designers	34	35	24	41	25	42	23	24

3.4.1. *Seasonal Summit Co-Design Participants*

81 individuals, not including the research team, participated across these eight summit design sessions. **Table 3-2** shows the total number of co-design participants in our seasonal summits over the two years by primary role. These included school-based personnel (educators, instructional aides, and principals), adult family members from each school, partners from community-based organizations, and children. The research team included project investigators, graduate researchers, and project staff across two universities, the school district, and a community organization that were responsible for project design. School-based personnel were majority middle-class and female (4 male K-2 teachers across the

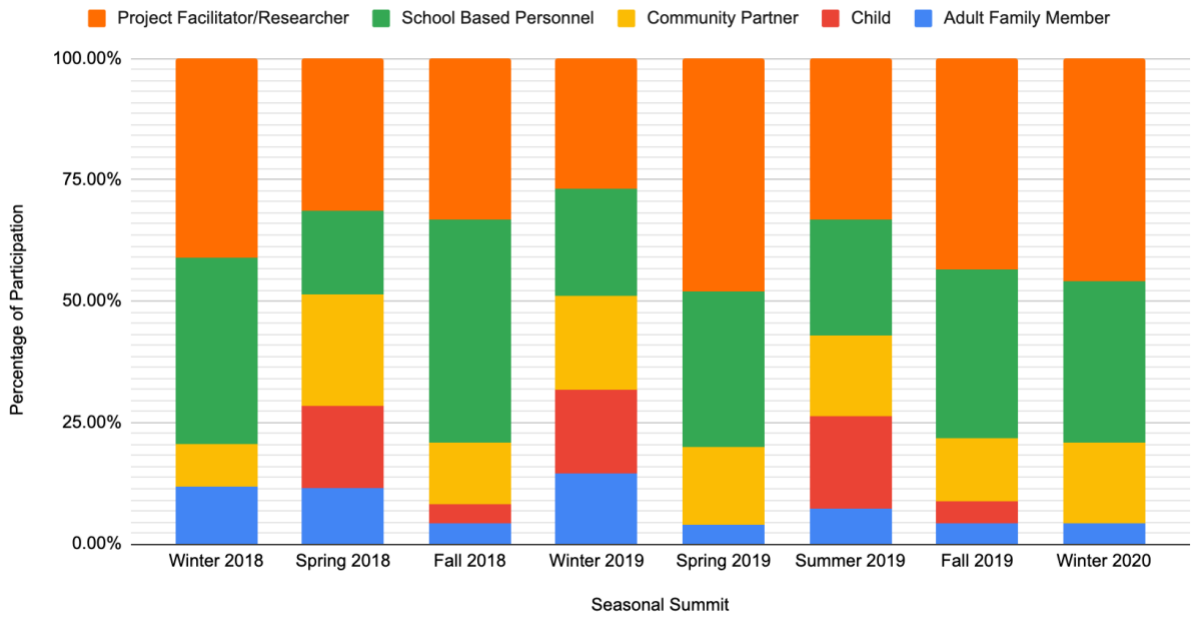
two years). A little over half the teachers were white (n = 15), the remainder were 1st and 2nd generation immigrants/descendents from China, Spain, Mexico, and Somalia (n = 13). Adult family members included mothers (10), fathers (4), and grandparents (3). A little over half were idenfied as people of color and immigrants (n = 10) and the others were white (n = 7). Children at the summits included K-2 students with their adult family members (above) as well as their younger and older siblings. Additionally, children included our (research team) own infants and school-age children (n = 7).

Table 3-2 Number of co-designers in seasonal summits by primary role

	Adult Family Members	**Children**	**Community Partners**	**School Based Personnel**	**Project Facilitators & Researchers**
Total Number	17	18	19	27	28

Figure 3-3 shows the percentage of each primary role represented at each summit, however, many of these individuals also held a multiplicity of roles as parents, grandparents, community activists, informal educators, and mentors that they used to design. As I discuss later in the paper, we intentionally designed for role porosity whereby individuals could take on multiple roles and leverage heterogeneous expertise in this design space. For us as a research team, this meant intentionally refusing erasure of our identities as mothers of infants, toddlers, and school-age children, as women and men of color, as white women and men, as multilingual language learners, and as researchers with institutional power and privilege (to name a few). The research team and school-based personnel made up the majority of primary roles during the seasonal summits.

Figure 3-3 *Percentage of LiP seasonal summit co-design participants by primary role*



As lead author of this paper and research assistant on the project, my own identity as a light-skinned, Latina, daughter of a Mexican immigrant and a White woman, wife of a White-settler man, and mother of two White daughters informed my design approach, facilitation, and interpretation of interaction. In particular, my role as a mother whose daughters participated as co-designers in these spaces - at times leading activity, participating in immersive outdoor experiences, or listening to the deliberation and design of adults - challenged me to think critically about whose identities and abilities were privileged or invisibilized. My daughters grew up in these design spaces over two years, shaping how we live and learn as a family. In addition to their participation as co-designers, my eldest daughter (age 6 at the beginning of the project) helped collate tools for the summits, pilot tools in our home/neighborhood and during summits, provide feedback on drafts, facilitate activities during summits, and give overall moral support. I thank the research team, and especially thank LiP Aunties Alice, Megan, Carrie, Priya, and Michelle and LiP Uncles Nat and Jordan for lifting up my girls' spirit in these spaces and upholding our design commitments to leading with children's vibrancy and brilliance.

3.4.2. *Seasonal Summit Data Collection*

Design, implementation, and reflection data were collected as part of the seasonal summit co-design research. Design data included weekly research and design team meeting minutes where we discussed (a) design objectives, activity structures, and mediational materials for the summits; (b) facilitation agendas and drafts of agendas operationalizing our research discussions; (c) material artifacts designed to scaffold co-design participation; and (d) presentation slide decks that served to pedagogically support expansive learning and participation.

Summit data collection included audio and video recording of summits, collective field notes, photocopies and photographs of artifacts, real-time content logs of major activities and participation, and real-time revision to slide decks. Audio and video collection included whole and small group conversations indoors. Chest-mounted go-pros and lapel microphones were used to collect audio/video data on children and adults during outdoor activity. Audio data were transcribed for all indoor activities. Field notes were written jointly by members of the research team during design activities, acting as an approximate transcription of unfolding activity and drawing attention to analytic notes (AN), observer notes (ON), and methodological notes (MN) for later analysis. These were written in Google Docs, allowing for real-time joint field noting and memoing. Additionally, activity start and end times were noted as well as time-stamps for particularly "juicy" moments that we may have wanted to quickly reference at a later date. Implementation artifacts included photocopies of individual and small group mediational tools and photographs of collective activity (i.e., artifacts too large to photocopy). Real-time content logs tracked major activities and co-designer participation at five-minute intervals.

Reflection data included audio recording of research team debrief conversations following the seasonal summit, field notes of the conversation, and weekly team research meetings notes reflecting debrief conversations and emerging analysis. Real-time content logs were refined and expanded to include key concepts connected to our rhizome. Additionally, metadata logs were created to catalogue and organize design, implementation, and reflections data by calendar year (Jan - Dec).

The remainder of this paper is organized around two rounds of analysis to better understand how we both designed for nature-culture complementaries in family-engaged science learning and changemaking; as well as how the conceptions and roles for families engaged were expanded (or not) in unfolding activity with co-designers. The first section is a design analysis of a subset of our seasonal summit data - those activities where families were explicitly framed and engaged in our co-design activities. In the findings section, I explicate twelve design practices that were utilized in our seasonal summits to center families. In the second section, I conduct a micro-longitudinal discourse analysis over the course of seasonal summits to explore how co-designers took up, negotiated, and expanded particular conceptions of families engaged in science learning and education in unfolding activity (DeLiema et al., 2015; Montaño Nolan, 2019).

3.5. SECTION 1 DESIGNING FOR FAMILIES ENGAGED

3.5.1. *Analytic Methods*

I began with a thematic analysis of our seasonal summits to understand when and how we designed for expansive family engagement based on our core design propositions and principles, particularly focused on nature-culture relations. I then created a secondary data set from the seasonal summit design data, focusing on activities where the goal was to explicitly center families' presence, knowledges, and practices in our project and in science learning more broadly. I reviewed facilitators' agendas and slide decks, then cross-referenced this list of activities with field notes of summit implementation to account for any redesigns. I found 48 designed activities where families were centrally positioned as necessary for equitable science education and educational changemaking out of 118 total activities. **Table 3-3** summarizes the number and proportion of family-centered activities found across each seasonal summit and as a total, with 40.68% of all activities focusing on families. The other activities focused on such topics as research design and consent processes, designing and implementing field-based science lessons in the classroom and outdoors, and key concepts in complex socio-ecological systems. Families were presenced - physically and conceptually - in activities beyond those directly designed for families and future analysis will explore this in more depth.

Table 3-3 Number and proportion of family-centered activities across seasonal summits

	Winter 2018	Spring 2018	Fall 2018	Winter 2019	Spring 2019	Summer 2019	Fall 2019	Winter 2020
# Activities Centering Families	5	3	9	10	4	7	2	2
Total # of Activities	16	10	23	24	11	23	4	6
Proportion of Family-Centered Activities	37.50%	30.00%	39.13%	41.67%	36.36%	30.43%	50.00%	33.33%

After creating an initial count of family-centered activities, I conducted a grounded analysis of the design materials - facilitators' agendas, slide decks, and material artifacts - for design objectives and activity structures (Strauss & Corbin, 1988). Analytic notes were logged in memos for each of the 48 family-centered activities. From this analytic memoing of design data and in connection to literature on solidarious co-design (Ishimaru et al., 2018; Family Leadership Design Collaborative, 2019) and place-based co-design (Bang et al., 2014; Marin & Bang, 2018; Marin et al., 2018), I created a coding scheme of 12 design practices that informed the design of family recruitment/participation at the seasonal summit as well as design of each activity. I also coded for the participation structures - how co-designers were engaged in the activity - as well as activity location (indoors or outdoors). **Table 3-4** shows the coding scheme for family-centered design activities across the seasonal summits (code definitions can be found in **Appendix 3A)**. Analytic memos were uploaded into Dedoose, a qualitative software program, and coded using the scheme described.

Table 3-4 Coding scheme for family-centered design activities across seasonal summits

Activity Design Practice Codes	Participation Structure Codes	Activity Location & Mobility Codes
Addressing space/time pragmatics	Material tool mediated	Indoors - sedentary
Recruiting whole families	Individual	Outdoors - mobile
Making explicit contributions	Small group	
Facilitating role porosity	Whole group	
Framing big ideas	Presentation	
Sharing histories of places	Question & answer	
Discussing recruitment strategies		
Thinking with data & big ideas		
Storying		
Rehearsing/piloting		
Designing objectives		
Designing tools and pedagogical strategies		

The first three design practices, (a) addressing space/time pragmatics, (b) recruiting whole families, and (c) making family contributions explicit were metadesign practices that framed our overall summit design and recruitment strategies. These practices were not coded at the level of activity. Design practices and participation structures were mutually inclusive and often complementary as we designed activities.

Activity locations and mobility affordances (sedentary or mobile) were coded as either indoors or outdoors. Activities indoors were typically sedentary - with two exceptions where we asked people to walk around the room and introduce themselves and ranged in various relational participation structures. Outdoor activities were mobile and involved walking the places, lands, and waters surrounding our design location as well as using tools to scaffold attention to particular scientific practices and phenomena.

I also cross-referenced data and consulted with the research team to gain additional perspectives throughout the analysis to better understand design intentions. In the findings section, I illustrate our

ecology of design practices and summarize our design intentions regarding the three aims of design practices employed in the seasonal summits to engage families.

3.5.2. *Presencing Design Practices*

Through iterative passes with the data, I clustered the 12 design practices into three broader categories that accomplished overlapping, yet distinct aims for engaging families in the co-design process, in school-based family engagement, and in science learning. These categories included designing for (a) physical presence of families in the project co-design and in family engagement with the schools; (b) conceptual presence of families' culturally-varied and place-based knowledges and practices; and (c) knowledge and practice co-creation. To illustrate these practices, I think with and extend the concept of *making present* as a practice of legitimizing families' and communities' right to dignified and just education, including the right to define and participate in changemaking processes (Barton & Tan, 2019; Squire & Darling, 2013). Barton and Tan (2019) define making present practices as,

> First, making present practices symbolically and/or in actuality reflect a struggle to have one's life or lived experiences legitimized. Second, they foreground relationality, linking places (home country and host country) and time (past, present, and future). The connection of places and time in practice is central to authoring a rightful presence because it helps to reconstruct place through the lived experiences of the oppressed (Squire & Darling, 2013). Third, making present practices disrupt binaries between outsider/insider and novice/expert "not by pursuing inclusion into an already established order;" rather, [they seek] to assert a new measure of justice even if that means undoing the order we currently exist in and benefit from (Vrasti & Dayal, 2016, p. 999). (Barton & Tan, 2019, pp. 8-9)

I argue that our Learning in Places family-centered design practices aimed to "make present" families, communities, and places through an ecology of physical, conceptual, and knowledge making practices across multiple scales of space and time. Further, making present in this context also meant refuting settler colonial endeavors to erase Indigenous and African descendent "presence." Building upon the pivotal work of settler colonial theorists such as Reardon and TallBear (2012), Veracini (2011), Wolfe

(2006) and many others, Bang and colleagues (2014) argue that logics of settler colonialism are manifest in "1) erasure of Indigenous presence, 2) staged inheritance of indigeneity by Whites, and 3) erasure of African descendants humanity through the structuration of slavery and resultant reduction to control of Indigenous absence from land" (p. 532). Thus, making present practices sought to disrupt such divisive and invisibilizing logics. Further, from the lens of nature-culture complementaries, we also sought to make nature – and human relations with/on nature – present through outdoor mobile design activities and critical storying of our relations of becoming on lands and waters. I discuss each of these three classes of design practices in some detail below. No single practice or even type of practice was sufficient in transforming such deeply entrenched and settled conceptions of and roles for families, which I evidence in the next analysis and findings section.

Physical Presencing Practices. Informed by equity-oriented literature in family engagement (Ishimaru et al., 2019), we designed for families to be physically present and intellectually engaged in our co-design processes and model a form of partnership predicated on addressing the power dynamics that routinely disengage families or prevent their meaningful participation (Ishimaru et al., 2018). Building from the learning sciences, these design practices sought to expand subject-object and subject-subject relations (as co-constituted) in our partnership and design processes (Nasir & Hand, 2006; Bang & Vossoughi, 2016). First, we intended to make space for families to share their experiences, stories, knowledges and practices on their terms, and have these drive the design of culturally thriving learning environments (Ishimaru et al., 2018). Often, families are conceptualized as beneficiaries of schools rather than knowledge-producers who can and should shape learning and educational decision-making, particularly in subject domains such as math or science (Booker & Goldman, 2016; Ishimaru, 2019). We sought to shift subject-object relations by re-positioning families as drivers of educational changemaking. Secondly, we wanted to cultivate new forms of relationships between educators and families predicated on a reorientation to learning on lands and waters. In other words, through joint learning and activity about and in the natural world, we hoped to sow new subject-subject relationships (Bang et al., 2016; Bang & Vossoughi, 2016).

Physical presencing design practices included,

a) addressing potential barriers to attendance and participation;

b) recruiting whole families, including extended family members, friends, and children; and,

c) making explicit how families would legitimately contribute to the project and learning in their children's school.

We were cognizant that holding design meetings during typical business or school hours would unduly burden working families who would re-arrange schedules to attend or be unable to be physically present at all. We therefore tried to hold all or some of the summit design events during weekends and/or evenings and, when we could, at a range of locations equidistant for all participants (i.e., at leadership schools, the University, district offices). When we held summits on weekdays, we made explicit that family-centered activities would take place during evenings.

We also aimed to reduce barriers to physical participation by offering transportation, translation and transcription of materials when requested, and inviting children to be present with us rather than asking families to find childcare. A core design objective was to refute age segregation in our design processes whereby children are physically distanced from the design of their own learning (Bang et al., 2020). Instead, we invited children to be physically close - inside of the design space with adults - and to participate in design activities with adults. This, for us, was another form of subject-subject-object repair.

Again, drawing from the literature on family engagement, families' physical presence in our design processes would not be sufficient to disrupt settled family engagement models. As Barton and Tan (2019) urge, rightful presencing goes beyond welcoming families into learning (or co-design) spaces as this assigns them status as "perpetually guests with attenuating agency" (p. 6). Many critical family engagement scholars also demonstrate that powered dynamics continue to operate in disingenuous ways at the interactional level between families and educators, as well as families and institutions, despite nominal calls for increased familial presence and partnership in educational environments (Ishimaru & Takahashi, 2016; Ishimaru, 2019). For example, Lareau and Horvat (1999) show that educators perceived and interacted with middle-class African American (i.e., hostile) and white families (i.e., advocates)

differently, despite the similarity in interactional behaviors. López and colleagues (2017) and Friedel (1999) also demonstrate that families are often recruited to "rubber stamp" educational decisions already made. These decisions nominally include families in decision-making, but maintain institutional power and status quo. Finally, focusing only on families who are physically present and participating in anticipated ways invisibilized the ways families engage in the education of their own children in their daily lives and communities (Barton et al., 2004; Lawrence-Lightfoot, 2004; Valdés, 1996; Valencia & Black, 2002). For these reasons, we also engaged design practices to visiblize and change these inequitable partnership dynamics and design with families' heterogeneous and place-based knowledge and practices, even and especially when they were not physically present.

Conceptual Presencing Practices. Conceptual presencing included our design practices for centering and legitimizing families' knowledges and practices in the project, particularly around re-mediating nature-culture relations from divides to complementaries as well as explicitly addressing powered dynamics. Four design practices were used in the seasonal summits to pedagogically support co-designers to "see," make sense of, reflect on, and expand our theories and practices in relation to the design of expansive learning environments and partnering practices. These practices were intended to frame co-designers' expectations for social participation (DeLiema et al., 2015; Erickson, 1996) and epistemic action (Chinn et al., 2011). **Table 3-5** shows the proportion of family-centered summit co-design activities informed by each of these conceptual presencing design practices.

Conceptual presencing design practices were,

d) facilitating role porosity to expand conceptions of and possibilities for families engaged in learning design;

e) framing big ideas around our rhizome (i.e., nature-culture relations; power and historicity; families, communities, and culture; complex socio-ecological systems; and field-based science);

f) sharing the "histories of place" where we conducted our seasonal summits; and

g) discussing family engagement experiences, strategies, and possibilities.

Table 3-5 Proportion of activities that conceptually presence families knowledges and practices across each design practice

Design Practice	Winter 2018	Spring 2018	Fall 2018	Winter 2019	Spring 2019	Summer 2019	Fall 2019	Winter 2020
Role porosity	20%	0%	20%	10%	0%	13%	25%	0%
Framing big ideas	60%	40%	30%	10%	0%	38%	50%	50%
Histories of place	0%	20%	20%	10%	25%	13%	25%	0%
Family recruitment	20%	0%	10%	0%	0%	13%	0%	0%

The most prevalent conceptual presencing design practices across the summits were (e) framing big ideas and (f) histories of place. Both of these practices were typically lecture style presentations, facilitated by research project members, with a few notable exceptions: we twice went on histories of place walks, and once asked families to read, make sense of, and discuss big ideas around complex socio-ecological sensemaking and field-based science practices. The practice of (d) facilitating role porosity in the design of family-centered activities was intended to make visible that all co-designers, regardless of their primary role and rationale for joining the project, are simultaneously part of their own families, part of the learning and design community, and part of the natural world. Further, this practice was meant to open space for co-designers to reflect on intersectional forms of power and privilege across their varied roles and identities. However, I found this role porosity was rarely designed in our family-centered activities. Initial analysis of transcripts of both family-centered and non-family centered activities suggests that role porosity may have been a refrain that asked co-designers to take the perspective of young children, families, policy makers, and more-than-human others in their activities (i.e., how would you approach this activity if you were a family with a student in your classroom?). This was, however, not coded in my analysis of design activities and more analytic work is needed to trace perspective taking in our designs. Finally, (g) discussing family recruitment strategies was often a small group activity where

school teams thought about how they currently engage families in partnership. This conceptual practice was often paired with knowledge-and-practice making practices (discussed in the next section) such as (i) storying, (k) designing objectives, and (l) designing practices and tools as co-designers imagined and designed new forms of partnership addressing their lived experiences.

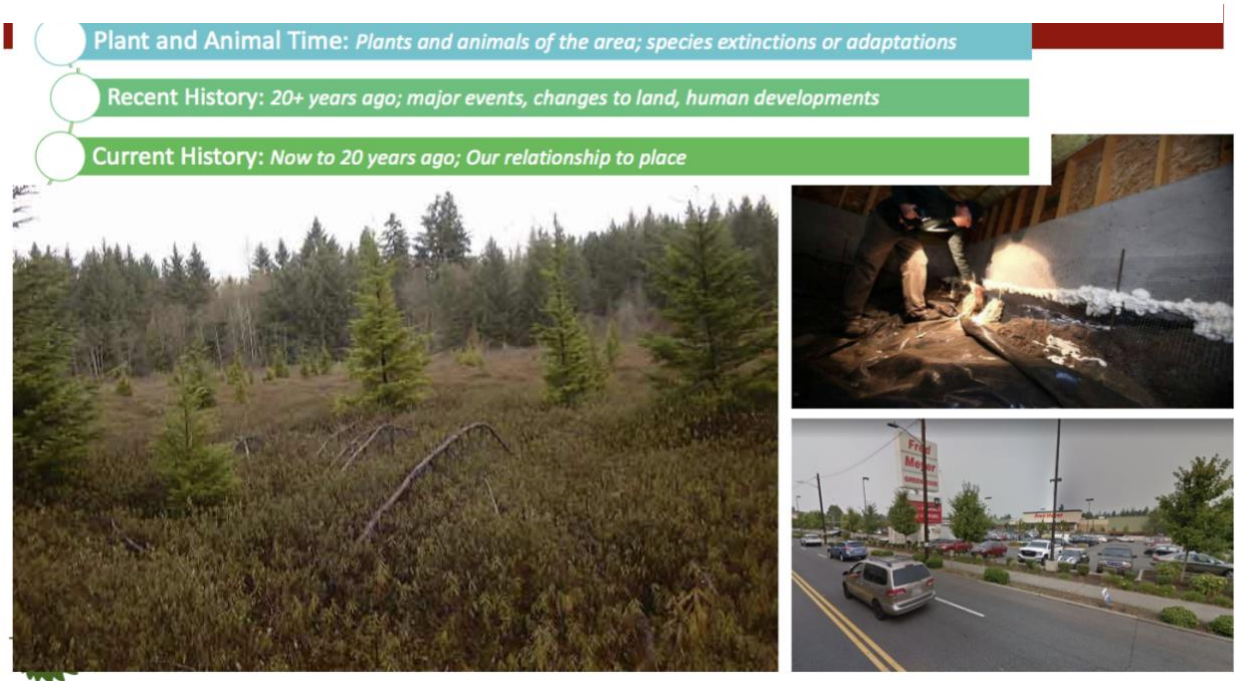
To illustrate conceptual presencing, I briefly describe the design practice (f) sharing "histories of place." This practice sought to make visible multiple dimensions of complex socio-ecological systems – specifically temporal dimensions (Learning in Places, 2020b) – as grounded in the lives of families and communities in the places where we held our design summits and reflected in the nature-culture decisions that impact these communities. The specific temporal dimensions were iteratively refined across the project years. Prior to each seasonal summit, the project research team conducted place-based research on the place where we would hold the summit - including walking the place (which was a specific practice that waned over time), reading historical artifacts, talking with community members of the area, etc. We also drew upon our own roles and relationships in these local places to inform our storying. Histories of place activities typically took the form of a power point presentation where a project team member told the history of the place, highlighting multiple temporal dimensions (past, present, and future across human and more-than-human perspectives). As such, these were often indoors in lecture style formats. Two exceptions included a histories of place walk led by a tribal community partner, and a tool-mediated walk and discussion about our own histories in this place.

In Fall 2019, we held the second day (Saturday) of our seasonal summit at Parkview Elementary. Parkview elementary is situated adjacent to a 200-acre park, Arroyo Park, featuring a riparian creek, temperate forest, cultivated apple orchard, and intertidal beach. Maya, a graduate research assistant on the project, took lead on conducting a place-based analysis of Parkview Elementary and the adjacent Arroyo Park, and organized the "histories of place" activity for this day of the summit. Maya identifies as an Indian-American female - whose mother emigrated from India and father is a European-American - with mixed identities as both a person of color and white. Maya is also part of a community organization that is working to restore the creek in Arroyo Park as an active salmon run. As such, she built upon her deep and

long-term relationships with the lands and communities to inform her analysis that spanned geologic time, plant and animal time, recent history, current history, and future possibilities.

Figure 3-4 is a slide from our Saturday Fall 2019 summit slide deck where Maya explicitly calls attention to multiple temporal dimensions and the range of nature-culture human decisions that are impacting local communities in the neighborhoods of Parkview Elementary. The corresponding text was a scripted description she used in this presentation to highlight plant and animal time, recent history, and current history.

Figure 3-4 Image from slide deck of fall 2019 seasonal summit



Much of [this region] was heavily forested, and actually there were many bogs. [This neighborhood] now sits on what used to be a peat bog. Peat bogs are accumulations of partially-decayed organic plant matter that form in wetlands, and there are dozens of them in hilly [region] where glaciers left a series of basins where the material could collect. Many of the areas were drained and filled to make way for early development by white Settlers in the area. For instance, when Fred Meyer in [this neighborhood] was built there was quite a bit of controversy over land use - in large part because that area sits on a former bog. Some argued the area should be preserved, others were worried about the development causing the land to compress and nearby buildings and homes to start sinking. Now, many homes in this area are actually sinking, and we see shifts in the road as well. (Slide 11, October 2019 Summit Slide Deck)

In lines 1-4 Maya drew attention to the geologic history of the lands and waters on which Parkview Elementary, surrounding neighborhoods, and Arroyo Park are situated. She used the past tense to describe the peat bogs and wetlands that made up the region and shows an image (far left) of what the lands likely looked like prior to white settlement in the area. Doing so was intended to give co-designers a conceptual vision of the lands and waters prior to European settlement. Importantly prior slides and those following this one highlighted Indigenous peoples' time as both prior to settlement and as currently on the lands and waters of this place. Further, day 1 of the Fall 2019 summit focused specifically on a history of the lands and waters from Indigenous peoples' time.

In line 5, Maya shifted from geologic and plant/animal stories to describe the human decisions - specifically made by white Settlers - that transformed the landscape from peat bog and wetlands. She narrated these decisions as occurring both in recent history "Many of the areas were drained and filled to make way for early development," as well as current history "when Fred Meyer was built." She then narrated the decision to build a grocery store as one reflecting multiple nature-culture relations that were negotiated in the decision-making process - "there was quite a bit of controversy over land use." She described two perspectives, both based in knowledge about the histories of the place as peat bog, yet reflecting differing orientations to why the grocery store should not be built (first, natural preservation;

second, city planning). In other words, through this story she aimed to demonstrate that in order to deliberate and make decisions about land use, deep knowledge about the lands and waters from multiple temporal perspectives is necessary. Not described in her analysis were the perspectives that ultimately decided to build the grocery store - ones that also reflected the desire by communities in the neighborhoods for food access as well as economic and political pressure from a major corporation.

In lines 9-10, Maya described the impacts to human built structures as a result of the decision to build a large complex on former wetlands: that compression in one location of the bog caused an upswell of water in other places - namely homes and roadways. The upper-right image shows water infiltration in the basement of a home in the neighborhood, showing the socio-ecological consequences of the decision to build a Fred Meyer shared by community members in the neighborhood.

Broadly, the purpose of this history of place activity was to enflesh how our rhizome lives in our ethical commitments to a science education that prepares learners and their families and communities to engage in socio-ecological learning, deliberation, and decision-making. The stories in this activity were reflective of the lived realities of the people in the co-design space - this was their Fred Meyer, their former peat bogs, and their responsibility for ethical futures for humans and more-than-humans. As such, these ideas and imperatives framed the subsequent co-design activities across the day (and years-to-come) and we intentionally facilitated back to these (and other) stories to think about what and how we could co-design science learning.

Knowledge and Practice Making Practice. Finally, knowledge- and practice-making included design practices that engaged co-designers in thinking and designing *with* families' knowledges and practices across the project design objectives. Physical presencing design practices brought families into the design space and conceptual presencing showed how and why families are the heart of consequential science learning; knowledge-and-practice making design practices engaged all co-designers in the actual design/re-design of ideational and material artifacts. Further, both physical and conceptual presencing largely relied on the project research team facilitating or shaping the activities (i.e., activities were largely lecture or question/answer format). Knowledge-and-practice making design practices encouraged more

active participation of co-designers from their multiple forms of expertise (i.e., small group and individual conversation and tool-mediated activity). As such, the activities inflected with these practices made space for co-designers to share, negotiate, and refine conceptions of families and their roles in science learning and educational changemaking in their public discourse. I explore in more depth in the next analysis and findings section.

Knowledge-and-practice making design practices included,

h) thinking with data and big ideas to sharpen analysis of implementation and inform (re)design across aspects of the project;

i) storying relations in places, lands, and waters, with systems of educations, and in science and garden learning;

j) rehearsing and piloting instructional materials and practices, in indoor (i.e., classroom) and outdoor locations, and in homes and communities;

k) designing objectives, including learning, partnering, and research objectives and iteratively refining these over time; and,

l) designing tools and practices that operationalize our design objectives and rhizome commitments to equity.

Table 3-6 shows the proportion of family-centered summit co-design activities informed by each of these knowledge-and-practice making design practices. Throughout the summits, we consistently provided opportunities for co-designers to shape our core objectives, and design the tools and practices that would operationalize these objectives – including reimagining and repairing inequitable forms of partnership. Further, by thinking with data collected as part of the research design our objectives, tools, and practices became more attuned to the demands of local socio-ecological activities. For example, in spring, summer, and fall 2019 we shared preliminary analysis around family-centered implementation and areas for growth and continued vigilance. In both spring 2019 and fall 2019 we focused on collective analysis of a series of family knowledge and practice sharing tools that we had, in previous summits, (l) designed and refined and (j) rehearsed/piloted as part of the summits. This analysis and these activities

conceptually presenced families who were not part of our co-design teams, while enabling us to fine tune theories and practices for science learning and changemaking.

Table 3-6 Proportion of activities that engaged co-designers in knowledge-and-practice making by design practice

Design Practice	Winter 2018	Spring 2018	Fall 2018	Winter 2019	Spring 2019	Summ 2019	Fall 2019	Winter 2020
Thinking with data & big ideas	20%	0%	0%	20%	50%	13%	25%	0%
Storying	40%	20%	10%	10%	100%	13%	25%	100%
Rehearsing & piloting	0%	40%	20%	30%	50%	25%	0%	0%
Designing objectives	20%	20%	0%	20%	25%	38%	25%	50%
Designing tools & practices	20%	40%	40%	20%	25%	13%	25%	0%

3.5.3. *Place-Based Co-Design … In Places?*

In addition to analyzing the series of design practices that informed our family-centered activities in the seasonal summits, I also analyzed how often we engaged in designing outdoors in the places, lands, and waters of local communities. As mentioned previously, prior to seasonal summits we sometimes engaged in place designing - walking the lands and waters of the places where we held our summits - noting affordances and constraints for learning. However, this practice was not routinized across our summits. During summits we sought to engage co-designers in outdoor place designing in order to ensure our design objectives, practices, tools, and partnerships reflected the place where we designed was an intended proleptic politic - creating the design conditions we hoped would root in science learning in our own designs (Bang & Vossoughi, 2016). However, I found only 7 out of 48 family-centered design practices (14.58%) occurred outdoors. In all but two instances, these design activities centered on (j) rehearsing and piloting activities and tools that would span classrooms and neighborhoods. The other time, we engaged in (f) histories of place walks. We engaged in outdoor design activities at other times during the summits, but these activities did not explicitly center families or expand conceptions for their

engagement in science learning or the project. Unintentionally, our designs replicated the over saturation of indoor activity during design, particularly around imagining families engaged in field science practices and learning. Building upon the place-designing work of Bang et al., (2014), Marin (2013), Pugh (2019), and Meixi (2019), there are clear indications that being outdoors and engaging in outdoor walks facilitates robust disciplinary sensemaking and expands opportunities for families to share their place-emergent knowledges and practices.

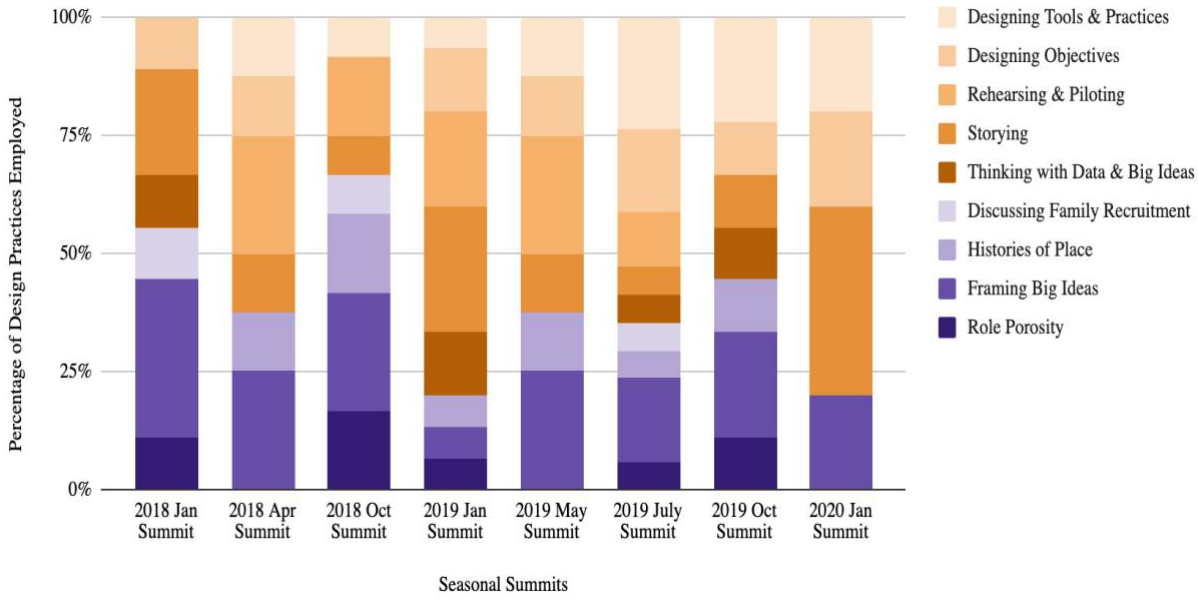
3.5.4. *An Ecology of Design Practices: Summary of Findings Section 1*

In the findings section above, I described three classes of design practices that Learning in Places utilized in our place-based co-design with families, educators, community partners: physical presencing, conceptual presencing, and knowledge-and-practice making. Across our seasonal summits we routinely engaged these as an ecology of design practices to specifically center families and familial and communal knowledges and practices - as taking place on lands and waters - in science learning and educational changemaking. **Figure 3-5** shows this ecology of practices and their use in the design of our seasonal summit activities over time. Physical presencing occurred across all seasonal summits, but were not coded at the activity level. As depicted, both conceptual presencing and knowledge-and-practice making practices were designed in each summit as we aimed to both expand conceptions of families in science learning and changemaking work as well as expand the corresponding sets of objectives, tools, and practices that would live in our model.

We anticipated that no singular design practice would accomplish desettling of normative, school-based science learning and family engagement from historically powered, divisive, and marginalizing models. More specifically, we anticipated that some design practices would re-mediate particular aspects of our rhizome while enabling the slippagage into normative discourse and practices along other dimensions of our rhizome (described in findings section two below). An ecology of design practices, therefore, allowed us to work across multiple and dynamic levels of changemaking (i.e., complex systems' transformation). I describe this process of expansion and slippage in our co-design

work in the following analysis of discourse about families engaged in science learning and educational changemaking over time, and across differing assemblages of design practices.

Figure 3-5 *Proportion of conceptual presencing and knowledge-and-practice making design practices across all seasonal summits from January 2018-January 2020*



3.6. SECTION 2: EXPANDING CONCEPTIONS OF AND ROLES FOR FAMILIES

A core foundation of Learning in Places was to re-mediate both school-based science learning and family engagement from nature-culture divides where humans are positioned as separate from, and often dominant over the natural world. As described previously, nature-culture divides are deeply embedded in science curricula, pedagogical practices, and the structure of everyday learning environments. Further, many family engagement practices often do not help educators engage families in discipline-specific ways (like science education), and often reinforce nature-absent practices and paradigms. Thus, we designed an ecology of practices to facilitate nature-culture complementaries by making visible families' place-based relationships with and on lands and waters as shaping opportunities for science. In addition to articulating our design practices and intentions, this analysis also sought to understand how conceptions of families and their roles in educational processes were taken up, expanded, or enclosed during unfolding activity.

3.6.1. *Analytic Methods*

I conducted a discourse analysis tracing themes of family engagement across the eight seasonal summits (DeLiema et al., 2015; Erickson, 1996). I focused specifically on public conversation of families, and as such analyzed only indoor activities with whole group participation found in round one of data analysis (described above). I expanded data analysis in this round to include summit field notes and debrief notes, transcript of whole group conversations, and cross-referenced audio and video recordings that were particularly rich to better understand unfolding interactional dynamics and conceptions of families. This produced a series of hot-spot episodes to conduct more in depth micro-longitudinal discourse analysis (DeLiema et al., 2015). I iteratively traced emerging conceptions of families - that is how co-designers framed the role of families in education and educational changemaking, using nature-culture relations as a lens - over time to see how these shifted. These findings were also shared with co-designers at subsequent seasonal summit.

In the following, I trace three distinct moments of activity where this conception of re-orienting to places, lands, and waters in our models of school-based family engagement opened up, expanded, and enclosed conceptions of families and their role in science and education. The first two excerpts unfolded during the first day (Thursday) then second day (Monday) of our first seasonal summit with co-designers in winter 2018. The third excerpt occurred nine months later on the second day (Saturday) of our fall 2018 summit.

3.6.2. *Excerpt 1: Place-Emergent Engagement in Routinized Familial Practice*

Four adult family members, all from Parkview Elementary, attended this first seasonal summit in winter 2018. Three were women (1 Asian American grandmother, 2 white mothers) and one white father. A core goal of this first summit was to lay the conceptual groundwork with our co-designers that would frame all subsequent co-design opportunities. We thus began by framing the big ideas that are foundational to our project (i.e., our rhizome), then had co-designers make sense of these big ideas in small groups utilizing “research briefs” to guide their sensemaking. Research briefs were 3-4 page

documents, created by the LiP research team, that synthesized key findings from cutting edge research and practice. The briefs shared at this first summit included (a) s*eeing and reasoning about complex socio-ecological systems in the early grades*; and (b) *building observational skills through family and school learning experiences*. Small groups based on school-affiliation read one brief in more depth and had a conversation about the big ideas and how they saw them in science education. A research team member joined each small group to help facilitate conversation. Parkview Elementary educators and family members read the brief *building observational skills through family and school learning experiences.* After small group sensemaking, we came together as a whole group to highlight key aspects of the small group conversation.

The following excerpt occurred in a whole group conversation after a research team member prompted the families to share their perspectives when it became apparent that educators were the only ones talking in the whole group conversation. Cecilia, prior to this moment alluded to her identity as a white working mother and her engagement with the schools as tenuous. In her introduction to the group, she said she was "not invited" by any teachers to join this project, but saw a flier for the summit in the school and felt compelled to join. She also narrated a history of school-based activism and advocacy with her son. I highlight three key dimensions of Cecilia's response: (a) she resisted the imposition of school-based practices into the home as well as home-like practices into the classroom, instead narrating Arroyo Park as the site for learning engagement (blue text); (b) she and her son engaged in the routine practice of walking and observing in the park (orange text); and (c) she articulated that expanding learning across home/school through walking in Arroyo Park can deepen and strengthen her relationship with her son (purple text)

***Cecilia*:** "How do I engage with this stuff… I usually ask [my kid] how his day was… **[but] it's not 'here's what we did in this subject and here's what I learned here'.** But I know it's in there and that he's learning it. But the times that I have engaged with him on this stuff is **when we are in these [outdoor] places.** We are lucky enough to be living right next to [Arroyo Park] right now, so **we go to [the park],** and when we see these things then he's like **'oh I remember this' and he talks about it.** And **I get this sense of what he's learning in his classroom because it's triggered because he's also learning about it in these places**.

And I guess if nothing else, just to say as a parent, I'm encouraged by this [Learning in Places] because **the more learning that there is in places like that, I feel like the more easily he and I will be able to share those moments.** And I will know **what questions to ask him, and he will guide me in his learning, and stuff like that**. Whereas when he's in his **classroom there is going to be more of a disconnect there.** (Cecilia, winter 2018 seasonal summit, day 1 transcript

Many models of school-based family engagement encourage families ask about and reinforce academic learning in the home. For example, Epstein and colleagues (2019) write:

> In a partnership, parents create *school-like families.* A school-like family recognizes that each child is also a student. Parents and other family members reinforce the importance of education, attendance, homework, and activities that build student skills and feelings of success. (Online resource)

Such a desire for school-like families has produced a robust series of practices and roles for families that shape their expected participation in school-based learning. These include taking a keen interest in and expanding what *students* are learning in their classrooms. In lines 1-2 Cecilia, however, began her response to our (i.e., researcher's) prompt by resisting the imposition of school-based practices in her everyday interactions with her son as the frame from which to understand her role as mother and educator in this design space. She took this up again in 12-13, as she said "whereas when he's in his "**classroom there is going to be more of a disconnect there."** Cecilia argued that both her

understanding of her son's learning and relationship are disconnected by physical and conceptual boundaries of the classroom. As she had narrated prior in the day, she was a busy working mother, volunteering time and labor in the classroom, although highly valued by educators and schools, was not something she was likely to do. While one could argue that the school-day was a barrier to her participation in her son's school-based learning, she chose to take the day off work to be physically present at the Learning in Places seasonal summit to co-design. Expanding the learning opportunities in Arroyo Park then, was considered valuable use of her busy schedule and a way to connect with her son's learning without centering school - either at the school building or in her home.

In her narration, neither the classroom nor her home were the center of interaction; instead, it is the outdoor places where mother and son share learning experiences. Cecilia described (lines 5-7) how as they walked the trails of Arroyo Park, her son would be prompted by something in the perceptual field and share what he had learned - that is what Pugh (2019) refers to as a place emergent epistemic action. Such outdoor epistemic actions have been shown to expand opportunities for ecological sensemaking and learning about the natural world (Marin, 2013; Bang & Marin, 2015; Pugh, 2019). Although she referred to her son as the one who initiated such place emergent epistemic actions on their walk, Cecilia did not cede her pedagogical role. In lines 8-11, Cecilia shared her hopes that the project would support her relationship with her son as they continue their routine walks of Arroyo Park - to "**share those moments.**" Further, she described her relationship of mutual learning and joint activity where she would "**know what questions to ask him, and he will guide me in his learning**" (lines 10-11).

Cecilia's narration of family engagement differs from the typical models of school-based partnership or conceptions of families engaged in their child's education. Cecilia did not describe either her volunteerism or desire for academic outcomes. Rather, she demonstrated her commitment to engaging her son in learning in the places that matter for their familial connection and wellbeing. Thus, instead of a school to home or home to school model, she articulated a desire for *learning* that expanded their opportunities for joint activity outdoors (McWayne et al., 2019). This kind of engagement envisions a shift in the role of schools and educators away from supporting academic advancement, towards building

the capacity of families to learn and thrive in the places that matter.

Undergirding this activity were two key design practices: framing big ideas (conceptual presencing) and thinking with data and big ideas (knowledge-and-practice making). The activity began by having co-designers read cutting edge research about how families (in their everyday routines) and classrooms (in their science activities) can support young learners' observational skills as a field-based science practice. Making sense of these ideas together and thinking about how families and educators already support observation practices opened space for Cecilia to share her experiences and hopes for Learning in Places and further engagement in her son's learning. I argue that this framing of outdoor learning and families' everyday experiences as contributing to scientific learning shaped her response about her own practices with her son.

3.6.3. *Excerpt 2: Slippages into Settled Expectations for Family Engagement*

School-based family engagement models are deeply entrenched and saturate imaginaries for the design of learning environments. Despite ample evidence and articulation from families for alternatives, routinized narratives about families and their role in education emerged in our design space. For example, on day two of the first seasonal summit, we asked school-based teams to collaborate and share out key successes or challenges across three dimensions of practice: (a) school gardens; (b) science learning; and (c) family engagement. From these stories we would co-design a series of design practices for equity that expanded on co-designers' success and addressed challenges across the stories told. Teams met briefly to confer, then designated a person to share (an educator in each instance) to the whole group. During share-out two members of the research team wrote down key ideas and practices from each group on chart paper. Analysis of these artifacts and transcripts revealed that families were largely conceptualized as beneficial to garden, science, and learning in the roles of classroom volunteers or as members of the parent-teacher association (PTA). During stories of family engagement, the PTA and other family leaders in the school were lauded for their success in creating space for events that brought families into the school. Many educators shared they were working on expanding their practice to better support families. Conceptions of busy, working families and intimidated families (i.e., hard-to-reach families) framed their

analysis of difficulties in getting families engaged. Some educators also noted powered and racialized dynamics within the PTA (i.e., between families) that contributed to low family engagement from nondominant families. However, despite Cecilia's presence on day 2, alongside the grandmother, mother, and father, educators dominated share out across all three dimensions. Although the conceptions on display were not explicitly deficit in tone, they invisibilized both the families physically present in the design space as well as the non-school sanctioned activities of families' educational endeavors more broadly outside of schools.

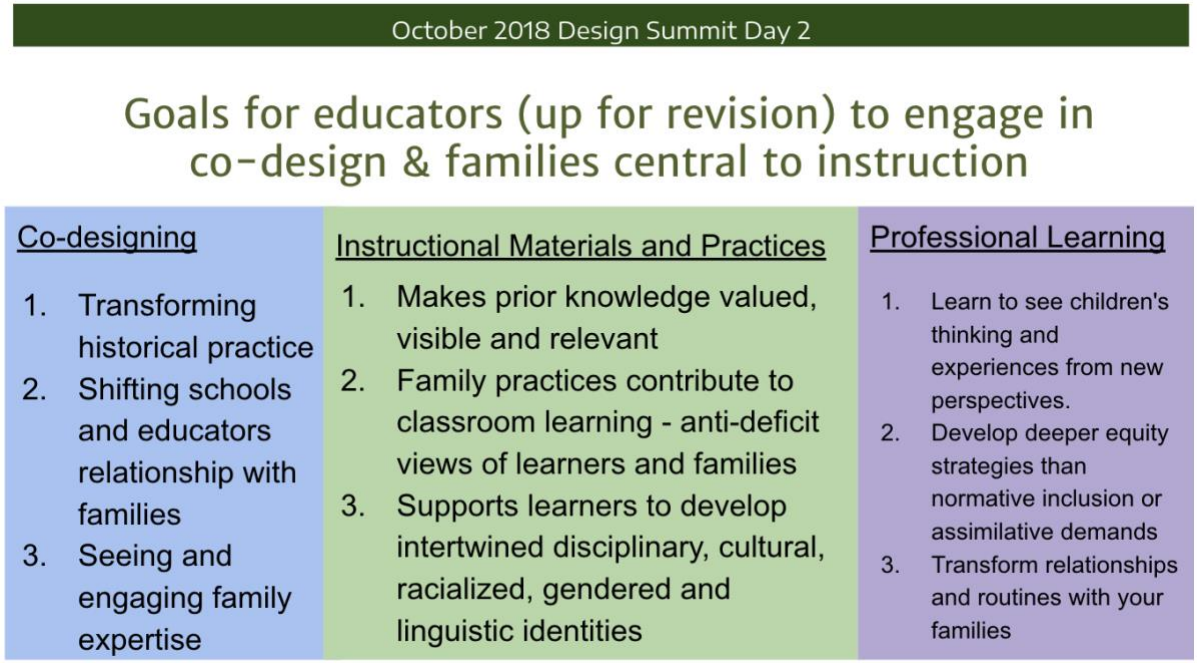
This activity was framed by two design practices: (a) storying (knowledge-and-practice making), and (b) designing objectives. We asked school-based teams to share their stories, including stories of family engagement, in order to design learning and partnering objectives that would enhance successes and address challenges. However, the stories told were narrated by educators and school-based framings of family engagement – narratives focused on opportunities for engagement were already there, families simply had to take advantage of them. In these conceptions, the role of educator in family-educator relationships was under-evaluated. Issues of power between schools and families or schools and communities were absent. Absent too were articulations of place-based learning that Cecilia narrated on the first day. Further, families in the design space were silenced by dominant narratives of their participation. Thus, despite initial shifts towards a nature-culture complementaries approach to family engagement - whereby partnerships might be built towards a collective learning on shared places – educator co-designers settled into well-worn patterns of family volunteerism and cultural events.

3.6.4. *Excerpt 3: Taking up Place-Based Engagement in Routine Educator Practice*

Over the course of a spring 2018 seasonal summit, monthly co-design sessions at each school, and through the production of family knowledge sharing tools, the research team worked to more explicitly address known settled expectations in family engagement, including known powered dynamics that cut across race, gender, and class. We also sought to make more explicit how we envisioned families in *science learning*. The spring 2018 seasonal summit more intentionally recruited nondominant families and planned activities for whole families - including children to help co-design science learning activities

that would span classrooms and homes, in the places that are important to families (i.e., neighborhoods,

Figure 3-6 Image from slide deck of fall 2018 seasonal summit



school yards, nearby parks and greenspaces, etc. In fall 2018, we expanded upon these co-design experiences with families to revisit goals for engaging families in science learning and in the project more broadly. Similar to winter 2018, we asked school-based teams on day 3 of the summit to reflect on their successes and challenges for engaging families and to think critically about whom they have engaged and why. Prior to breaking into small groups, the research team shared our collective goals for engaging families. **Figure 3-6** is an image of our slide deck highlighting these goals, including goals for (a) engaging families as co-design partners in the project and in designing learning opportunities within the classroom, (b) designing instructional materials and practices to support educators in transforming their practice, and (c) highlighting key areas for personal reflection and growth. After a brief discussion of these goals, co-designers broke into small groups to revise and expand these goals in light of their success and challenges.

The share-out included particular strategies for making prior knowledge valued, visible, and relevant including additional cultural event nights and learning more about the different cultures

represented in the classroom. One project investigator cautioned that such practices might reinforce tokenizing some families or recreating a show-and-tell model of family engagement rather than deep engagement in creating sustainable and long-term relationships. An educator – Ms. Poppy – followed with her personal goals based on successes she'd had during the previous school year and her own reflection on her engagement practices. Ms. Poppy identifies as mixed race, Mexican-American, female, 2nd grade teacher; however, in the following excerpt, we see Ms. Poppy's identity shift in relation to her sensemaking with families. I highlight three key dimensions of Ms. Poppy's personal goals for engaging families: (a) she aimed to routinize walking practices in the places she knows her classroom families walk (i.e., Arroyo Park) and invite families into the classroom over time (orange); (b) she also planned to extend beyond school hours to walk these same places and let families lead (purple); and (c) she intended to re-purpose events that disproportionately compel nondominant families into schools towards intergenerational learning and thriving in places (blue).

I have two goals [for family engagement] that I was hoping you [small group] could add…but like an **open invitation to walks in your classroom outside.**

Hannah [kindergarten teacher] is really good at ... Last year **she was going pretty much every Friday, and just doing like a 30-minute**. And it was just kind of like an open invitation for parents to join. And so I'm trying to start that this week as well, and when it's happening every week, the kids are going to talk. **Because I think the kids right now are cultural brokers**, until we can solve that, and so they are the ones who are gonna be saying like, "Every Wednesday we go, every Wednesday we go." And then hopefully, **more often we'll get more families to join us on those walks.**

The second idea was like [going on a walk on] a Saturday. Because we talked about school days and work schedules. **So like a monthly Saturday, family walk this summer.**

Our **summer school program, not shockingly, has a higher population of students of color and ELLs** than our normal school year population. So we had a parent night for the first summer

of the program, **we had a parent night this year.**

And so before parent night, we invited families to come on a walk, and I only got two ... I had two families, but one was an Eritrean family, Tigrinya speaker. And the other was a Guatemalan family, Spanish speaker. And then I had two instructional assistants. And then me.

And my whole point was like **I'm not going to lead this. I'm gonna see what the kids say.** And it was **both families, older siblings, younger siblings**. And it was just like ... I can't speak to how wonderful it was to just have like these 10 people, and I was the only white person. And I'm a mixed race person. I was the only white one, and it was just like this cool moment. And **these families who lived in this neighborhood had never gone to the workshop before**. And they're a walking distance from the school.

Ms. Poppy's first goal was to routinize walking in her classroom practice in order to create a regular pattern for students and family volunteers. She articulated how students would talk to their families "**Because I think the kids right now are cultural brokers."** Ms. Poppy recognized that she did not have a relationship with the majority of the families in her classroom and instead relied on children to "broker" relationships between classroom and home. She recognized the undue burden and injustice of putting young children, especially nondominant children, in such roles (lines 6-7, "until we can solve that"); however, was willing to leverage that continued connection given its success in Ms. Hannah's class. Ms. Hannah is the kindergarten teacher at Parkview Elementary who had previously routinized weekly walks with her classroom, and the regular schedule facilitated engagement from families who could join the walk. Ms. Poppy recognized the volunteering barriers to some families (lines 8-9) and also considered facilitating walks on weekends.

Ms. Poppy then described the summer school program that "**not shockingly, has a higher population of students of color and ELLs."** In this phrase, Ms. Poppy recognized the disproportionate failure of schools to support students of color and English language learners who are then compelled to attend summer school. She also reflected on how this opportunity afforded intergenerational learning (a

recurrent theme for Learning in Places) with families typically considered by schools as "hard-to-reach." As she narrated her positionality with these two immigrant families, her own identity briefly shifted "I was the only white person. And I'm a mixed race person. I was the only white one" (lines 20-21). Ms. Poppy reflected at various times in our design sessions on her identity as the light skinned daughter of a Mexican American father and white mother, growing up in a middle-class family in a predominantly white community in Southern California and not speaking Spanish. In this excerpt, Ms. Poppy inflected notions of class, immigrant status, and melatonin into her narration of being both white and mixed race.

She also shared how she re-mediated at least a portion of the parent night from a typical school-based model - where they would receive information on how best (or how to better) support their students in the home - towards shared expertise. She said "**I'm not going to lead this. I'm gonna see what the kids say"** (line 18). In so doing, she intentionally repositioned expertise from the traditional teacher-as-facilitator role and unintentionally put young people in the role of brokering the relationship between educator and family member. She could easily have said "I'm gonna see what the families say," but she still envisioned power dynamics flowing through young people as the "shared" point of contact. This refrain of keeping children as the point of contact between schools and homes and teaching children to be brokers who might "teach" their families how to use a particular knowledge and practice sharing tool, or engage in a field-based science activity were recurrent.

3.6.5. *Summary of Re-Orienting to Places, Lands, and Waters in Family Engagement*

Ms. Poppy narrated three family engagement practices that take up what Cecilia described in the first design summit as deepening intergenerational learning opportunities and moments for shared connection in the places, lands, and waters of families' everyday lives. These can be seen as an ecology of practices that Ms. Poppy is adopting that would afford participation from some families and constrain participation by others. I argue that taking an ecological approach to family engagement practices mirrors our own design practices for engaging families, and may facilitate a kind of design approach to learning and partnership taken up by Ms. Poppy and her colleagues who adopted similar approaches. This design approach resists the notion that a single activity or practice is able to shift systems of inequity; rather, by

mobilizing an ecology of practices Ms. Poppy hoped to transform the system at various levels. In the following school year, we (educators in both schools and research team members) hosted a series of family walks on evenings and weekends - themed to seasonal phenomena (such as nettle, horsetail, "how do you know it's spring," and beach walks).

These practices engage a kind of nature-culture complementary that recognizes families' relationships on the places surrounding schools as fundamental to wellbeing and potentially transformative for school-based partnerships and science learning. It was not simply the act of being outdoors that was potentially transformative, for these places are not neutral. Indeed, these outdoor places are intersectionality charged reflecting histories of Indigenous removal and erasure, violence against men of color, fear and violence against homeless individuals, among others. Rather, I argue that it was because these places demanded a kind of learning anew from both educators and families to observe, make sense of, and deliberate about scientific issues affecting these places that was transformative. This kind of expansive learning on lands and waters provided alternative configurations of home-school relations outside of traditionally-held school-based epistemic authority.

We (LiP research team) also recognized that Ms. Poppy's (and the other educators') efforts to routinize walks would also not be enough to conceptually presence the heterogeneous knowledges and practices of families in classroom instruction. We thus added to this ecology of practices a series of homework tools that would boundary cross between homes and schools and provide opportunities for families' to shape classroom learning; as well as afterschool intergenerational programming to co-design and install an outdoor learning site. In the third dissertation paper, I explore the potential for these tools to elicit and facilitate complex socio-ecological systems sensemaking through re-mediation of nature-culture relations in field-based science practices. Analysis of the afterschool programs is underway.

3.7. CONCLUSIONS & IMPLICATIONS

Learning within and across home and school relations has long been considered within dichotomous frames, reinforcing powered binaries between the cultural knowledges and practices of learning in home/community settings and learning in schools (McWayne et al., 2019). Emphasis on

cultural mismatch between homes and schools has generated a number of efforts to reduce mismatch by making homes more like schools or schools more like homes (Ishimaru et al., in prep.). While many family engagement paradigms encourage school to home relationships, where the flow of knowledge, power, and influence centers schools and schooling, there is a growing call for reciprocal relations and home-to-school relations where families exert far more control over administrative and curricular decisions, based in familial values, knowledges, and cultural practices (e.g., Sheridan & Kim, 2015; McWayne et al., 2019; Moll et al., 1992).

Across these models, and expanding beyond them, there are also scholars and practitioners that recognize the porous nature of home-school relations and seek to disrupt the Cartesian divide between the two. This body of scholarship honors the contradictions between (and within!) these distinct physically and conceptually-bounded spaces, while also honoring the historicity, power, and practices that are locally unique (Bang et al., 2010, 2016; Bell et al., 2012; Headrick Taylor, 2017). The research presented in this paper intercedes in the porous space between home and school learning, articulating a model for presencing families to cultivate rigorous scientific learning and meaningful engagement with local social + ecological issues of families and communities. Conceptualizing home-school relations in this way opens space for attending to the contradictions between home-school activity systems in ways that may disrupt Cartesian binaries as well as find home-school "paradoxes" (Ishimaru & Takahashi, 2017) as generative for transformative changemaking. Such a view envisions and seeks to enact home-school relations as potential sites for sustaining diverse families and communities, and also sustaining the lands and waters *with which* we live.

3.7.1. *Families, Communities, and Places in Axio-Onto-Epistemic Relationality*

In the following, I outline two key areas of accomplishment and ongoing tension in our co-design work related to nature-culture relations in family engagement. The purpose of this discussion is to highlight how we might expansively design for and with families, and how we might anticipate slippages into settled expectations and practices. I focus first on roles for families in science learning and

educational changemaking. Secondly, I make the case for places, lands, and waters as sites for expansive learning and partnership.

In our designs, we sought to cultivate expansive roles for and conceptions of family and community leadership and collaboration. Many scholars have long critiqued the aims of family engagement as being firmly rooted in deficit ideologies that are based in white supremacy and imposed through colonial structures, practices, and discourses that mirror broader socio-political processes of inequity (for review see Baquedano-López et al., 2013; Bang et al., 2018b; Fine, 1993; Lawrence-Lightfoot, 2004; Ishimaru et al., 2016; Nakagawa, 2000). They argue that by explicitly naming family engagement as a socio-political process, the underlying logics and manifestations of colonization and racialization - vis a vis structures, policies, practices, and discourses - may be identified, interrogated, and rejected (Garces et al., 2017; Sanders & Molgaard, 2019; Wilson Cooper, 2019).

This body of scholarship has worked to re-mediate the role of families engaged in educational changemaking towards systemic repair from many decades of harm caused by settler-colonial and racialized aims of family engagement and schooling (e.g., Booker & Goldman, 2016; Sanders & Molgaard, 2019; Barrueco, 2019). Further, many call for affirming and desiring heterogeneity, reflexivity, and learning in how educators approach both engagement/partnership work as well as their own teaching practice (e.g., Barton & Tan, 2009; Fantuzzo et al., 2006; Rosebery et al., 2010; Warren et al., 2020). Finally, there is increasing demand to engage families in addressing here-and-now communal issues and (re)imagining possible futures through joint activity (e.g., Bang et al., 2016; Ishimaru et al., 2018; McWayne et al., 2019). This has meant foundationally challenging models where families are conceptualized as beneficiaries or deficient, or models that privilege the roles and practices of White, middle-class parents in educational settings over and in replace of nondominant families and communities (Ishimaru, 2019).

There is less clear commitment across the literature, however, to address *settler* aims, goals, and strategies of family engagement. The near silence from non-Indigenous perspectives of how land and place are conceptualized in family engagement entrenches settler-futurities. For this reason, we see the

need for re-placing nature in our conceptions of engaging families for decolonizing education. We engaged an ecology of design practices that honored families place-based knowledges and practices as contributing to science learning and educational changemaking. These included facilitating role porosity; framing big ideas; sharing histories of place; thinking with data and big ideas; and storying. Further, we sought to expand field-based science learning opportunities across the places young people inhabit and the lands and waters shared by schools and homes. To support this, we engaged the design practices of rehearsing and piloting field-based science activities; thinking with data and big ideas; designing objectives; and, designing tools and practices. By utilizing an ecology of design practices, we sought multiple leverage points to transform systems of family engagement from historically disciplinary-agnostic, and historically inequitable dynamics towards place-based science learning.

Through this analysis, we saw accomplishments recruiting families to attend our seasonal summits, conceptually presencing families' vibrant contributions to science and changemaking, and designing with families knowledges and practices. We also saw that systemic rifts reopened in our design work. Educators continued to question the capacity of families to engage in rigorous science or share their deep knowledges of (in)justice and complex systems. Relying on deficit conceptions of families, educators proffered a model that centered young children as the contact point for educators to teach children how to perform science activities that they could teach their families. However, these conceptions were not static, and we are hopeful that multiple learning opportunities and engagement with families in the co-design of the project will make visible families' robust knowledges. The analysis in this paper suggests that re-orienting to places, lands, and waters may shift such deficit conceptions as educators and families engage in shared activity.

Place based and land based education hold promising theoretical and methodological insights for designing learning that immerses us in outdoor activity and cultivates relationality with lands, waters, and more-than-humans (Bang et al., 2014). Place-based science education emerges amidst a groundswell of community-based models for ecological management and decision-making that build upon "local," "traditional," or Indigenous knowledges (e.g., Berkes, 2017; Farhan Ferrari et al., 2015; Olsson & Folke,

2001; Romero Manrique de Lara & Corral, 2017). Broadly this movement towards local socio-ecological systems monitoring and governance argues that communities are most attuned to and impacted by fluctuations in ecological systems, and as such have developed reflexive and culturally-situated learning and feedback processes that can be leveraged in sustainable land management (Farhan Ferrari et al., 2015, see also Atran et al., 2005). To better articulate a conceptualization of place in education, Gruenewald (2003) offers five dimensions that begin to encapsulate and extend extant literature in critical ways. These dimensions include, (a) perceptual; (b) sociological; (c) ideological; (d) political; and (e) ecological and draw upon critical theories to illustrate a conception of place that accounts for and confers agency to places and more-than-humans. Further, power and privilege manifest in conceptions of place and placemaking in ways that demonstrate the liminal placing of racialized, classed, immigrant, and Indigenous bodies in society broadly and education specifically (e.g., Tuck et al., 2014).

This conception of place imbues and vividly anticipates socio-political and historical constructions of place and asks educators to help students make sense of varied and overlapping cultural conceptions of place, and over time. This denies the possibility of singular manifest desires for place and opens possibilities for re-imagining social relations with the places within which we live and learn. Further, this conception of place premises phenomenological approaches to learning in/with place and asks us to reconsider how we ground family engagement *experiences* as local to particular political, social, and ideological imaginings. In this way, constructions of nature and culture are intimately entwined in the co-production of new knowledges that expand what counts as disciplinary knowledge (e.g., the inclusion of traditional and Indigenous knowledges and practices in environmental education) as well as engagement of families and communities in education that directly impacts their wellbeing. Further, place is arguably offered as educational inoculation for young people against rapacious ecological destruction and consumerism, or panacea to combat adult stagnation in addressing global socio-ecological crises. However, the conditions in which we find ourselves socially, ecologically, and economically entrapped by globalization and neoliberalism are the same settler-colonial forces that

dispossessed Indigenous peoples from lands and dehumanized Black and Brown bodies for chattel labor on said lands (e.g., Calderon, 2014; Tuck et al., 2014).

Dolores Calderon (2014) and Megan Bang and colleagues (2014) offer complementary analyses of the ways in which settler colonialism shapes and pervades education, including place-based education, thus requiring a re-orienting of space-time ontologies in **land education**. Calderon (2014) contends that land education is well suited to articulate settler colonial imperatives in conceptualizing place and in developing pedagogies of place that decolonize and imagine "elsewheres" to settler colonialism (Bang et al., 2016). Calderon (2014) identifies five elements of land education that seek decolonization in and through education. Land education (a) centers relationships between land and settler colonialism; (b) challenges us to consider the politics of naming; (c) requires one to move towards a decolonizing reinhabitation of place; (d) requires us to consider Indigenous agency and resistance tied to Indigenous cosmologies; and (e) destabilizes the local.

Our co-design work sought to emplace science learning and family engagement objectives and practices in the lands and waters of communities. Through design practices such as sharing histories of place, framing big ideas, designing objectives, and designing practices and tools, we sought to expand conceptions of places, lands, and waters and human relationships (including family-school relationships). We also sought to refuse Indigenous erasure through: leadership by Indigenous women on the research team, explicit acknowledgement of the Indigenous peoples on whose lands and waters we design, engaging Indigenous sovereignty and knowledges in instructional materials and pedagogical practices, partnering with local tribes. We made some shifts in moving outdoors, however many of our family focused activities perpetuated indoor activity system. Further, the saturation of indoor learning and partnership and continued nature-culture divides are pervasive in school-based learning. Simply moving outdoors does not ensure nature-culture complementaries, but may reify conceptions of human domination over the natural world as the outdoors is seen as "classroom" for learning. Rather, ongoing work is needed to also re-mediate the agentic role of more-than-human others in science learning, deliberation of ethical responsibilities and possibilities, and partnership practices for socio-ecological

learning decision-making. Indigenous scholars are calling for expansions of the conception of "families" to also include the lands, waters, and more-than-human other relations who are vital for Indigenous family and communal wellbeing (Barajas-López & Bang, 2018; Bang et al., 2018b; Garcia, 2014). Such calls push for reciprocal nature-culture relations, a form of nature-culture complementaries that affords agency, rights, and responsibility to more-than-human others (Bang & Marin, 2015; Medin & Bang, 2014).

This paper presented only a portion of the story-so-far (Massey, 2005; Meixi, 2019). Our design work continues and we have gotten sharper in our critique of institutionally-based family engagement and more robust in our analysis of the possibilities for seeding family engagement through a re-orientation to places, lands, and waters (Learning in Places, 2020c). As such we have produced a series of frameworks that help frame and operationalized our rhizome in educational practice. A systematic analysis of the range of conceptions about families engaged in education across the seasonal summits and co-design sessions is underway to highlight the conceptual landscape as it evolved over the project years. And we continue to envision new design practices for engaging families in place-based co-design.

3.7.2. *Family-Engaged and Place-Based Implications for Co-Design*

Our ability to collectively learn about and transform social and ecological relations at multiple scales of activity may well determine our futurities (e.g., Berkes, 2017; Bang, Faber, Gurneau, & Soto, 2016; Whyte, 2013). The 21st century heralds challenges that intimately link the survival of diverse languages and cultural repertoires - and the people who practice them - with the survival of diverse species, lands, and waters (e.g., Gorenflo et al., 2012; Whyte, 2013), that is social and ecological worlds. This may yet necessitate new forms of family engagement and partnership with systems of education in ways that facilitate axiological, ontological, and epistemological reorientations to places, lands, and waters as consequential to learning and decision-making (e.g., Bang et al., 2016; Gruenewald, 2003; Whyte, 2013). For example, rapidly changing climates and ecosystems as well as the technological capacity to gather new forms of data necessitate field-based science education to support robust complex systems learning and build data informed decision-making skills (Berkes, 2017; NRC, 2012).

Concurrently, education that seeks to make learning consequential and connected to the daily lives of families and communities benefits from leveraging the heterogeneous and place-based knowledges and practices of communities (Gruenewald, 2003; Rosebery et al., 2010; Warren et al., 2020). Shifts in policy and research reflect this need for equitable science education with greater inclusion of field-based sciences in K-12 and more attention to interactions between natural phenomena and human communities (NRC, 2012; Schwartz et al., 2017).

This paper shared co-design practices that sought to both engage families in educational changemaking and re-orient to places, lands, and waters as consequential to both science learning and educational partnerships. Through a design analysis, I highlighted an ecology of design practices that anticipate known settled edges of engaging families in expansive science learning and educational changemaking and aim to reorient partnering practices to places, lands, and waters. I argue that no single practice can achieve the kinds of systemic transformation necessary for addressing the mounting 21st century design challenges; rather, an ecology of practices that orient to families, communities, and places is necessary to desettling science education and co-design partnerships. Despite well-intentioned designs, the analysis in this paper highlighted slippages in settler-colonial enclosures and deficit conceptions that stymied meaningful engagement and routinized power dynamics. Rather than perceive these as design flaws, making visible such deeply held conceptions and settled practices enables a kind of critical reflection necessary for systemic repair (Booker & Goldman, 2016).

4. PAPER 3: RE-CONFIGURING HOME-SCHOOL PRACTICES TOWARDS EXPANSIVE SCIENCE LEARNING

4.1. INTRODUCTION

Engaging families and communities in education is necessary to co-creating and sustaining culturally-thriving and academically stimulating places for socially and ecologically just futures (Barton et al., 2004; Bang et al., 2012, 2014, 2016; Ishimaru et al., 2018). A wave of research demonstrates that discipline-specific learning - like science education - is more meaningful and engaging to students when it directly draws upon their diverse cultural knowledges and repertoires of practice, learned in family and community contexts (Barton et al., 2004; Bell et al., 2012; Caspe et al., 2018; Gutiérrez & Rogoff, 2013; Moll et al., 1992; Nasir et al., 2020; NRC, 2012; Nasir & Hand, 2006; Rosebery et al., 2010). Further, burgeoning scholarship calls for designed learning environments that consequentially expand opportunities for nondominant students, families, and communities to engage in social and ecological changemaking, while desettling the presumptive hegemony of Western axiological, ontological, and epistemological claims to superiority (Vossoughi et al., 2016).

Current models of early-grades (K-3) science education and school-based family engagement, however, are not generally designed to support such expansive science learning (Barton et al., 2004, NRC, 2012), particularly in the outdoors (Subramaniam, 2018). Many students in the early grades continue to experience science education as a set of immutable facts to be memorized (NRC, 2012), abstracted from their daily lives and, consequently, disconnected from their developing cultural and disciplinary identities as young scientists (Bell et al., 2012; Tzou & Bell, 2010). If young students experience outdoor education, it is often disjointed from in-class science instruction leading to incoherent scientific learning across places (Subramaniam, 2018). Additionally, when engaged by schools, many families continue to experience assimilatory and reductive practices that reinforce Western-centric onto-epistemic dominance and powered relations between schools and families (Bang et al., 2018b; Barton et al., 2014; Ishimaru et al., in prep.).

A surge of design research highlights the promising role of curricular and pedagogical resources that scaffold learning environments towards expansive science learning indoors as well as outdoors. These studies demonstrate that, with appropriate scaffolds, students can learn about complex systems and phenomena (e.g., Yoon & Hmelo-Silver, 2017), particularly through field-based science practices (Eberbach & Crowley, 2009). However, these designs typically target upper elementary (3rd grade and up), middle, and high school grades (Danish, 2014), continue to be disconnected from children's home ways of knowing, doing, and being (Tzou & Bell, 2010), and are often abstracted from the places where children and families live and learn (Pugh et al., 2019). This paper examines how re-configuring home-school practices, through tool-mediated activity, can be designed for expansive science learning in the early grades.

4.1.1. *Research Overview and Questions*

This dissertation paper describes the co-design and implementation findings from an analysis of designed activities and material tools, called *family knowledge and practice sharing tools* [FKPS], created as part of a larger NSF-funded participatory design research project. Learning in Places engages young children, educators, families, community leaders, and university-based researchers in field-based seasonal science learning. Leveraging third generation cultural-historical activity theory (e.g., Engeström, 2001) and land-based education (Bang et al., 2010; Simpson, 2014), project researchers co-designed (Bang & Vossoughi, 2016; Ishimaru et al., 2018) activity systems that emplaced science learning across schools and neighborhoods. The FKPS tools were designed within these activity systems to act as both mediational devices, eliciting and facilitating critical scientific thinking and practices (Wertsch, 1994; Vygotsky, 1962; Nolen et al., 2020), as well as boundary objects (Akkerman & Bakker, 2011) that supported Next Generation Science Standards (NGSS)-aligned investigations across places. In particular, we intentionally scaffolded for routinized sensemaking habits bridging indoor (in classrooms and in homes) and outdoor (in school yards, gardens, and local greenspaces) science learning. The analysis and findings taken up in this paper centralize the importance of designing for meaningful home-school practices that open space for complex socio-ecological systems learning. As such, this paper focuses on

describing the design characteristics of the tools as they relate to our design propositions as well as a content analysis of familial knowledges and practices elicited by the tools[7].

My research questions for this analysis were:

1. *How can homework tools re-configure boundaries between home-school relations, knowledges, and practices related to expansive field-based science learning?*
2. *What kinds of epistemic practices and knowledges, specifically in relation to our core design propositions, were elicited from families using these tools?*
3. *What design characteristics of our activities and tools afford and constrain expansive science learning?*

4.2. THEORETICAL AND CONCEPTUAL FOUNDATIONS

This paper builds upon sociocultural and cultural historical activity theories, which posit learning as mediated by individuals' participation in cultural practices over time, mediated by places, lands, and waters, and mediated by tools and artifacts in goal directed activity. In this section I describe how these broader theories drive our desire to re-configure home-school practices towards expansive science learning. I also highlight a conceptual framework organized across three core constructs - socio-ecological sensemaking, nature-culture relations, and field-based science - that we contend synergistically work to disrupt historically powered binaries between home and school and re-orient towards place-making as a home-school practice with transformative possibility.

4.2.1. *Theoretical Grounding: Learning as Culturally and Contextually Mediated Activity*

Learning as Culturally Mediated. Sociocultural theory begins with the premise that culture is *not* a set of fixed traits or beliefs prescriptively ascribed by racial/ethnic membership (Lee, 2008; Gutiérrez & Rogoff, 2003). Rather, culture is "both carried by individuals and created in moment-to-moment interactions with one another as they participate in (and reconstruct) cultural practices" (Nasir & Hand,

[7] This complex and multi-layered project incorporated additional designs to cultivate equitable collaborations with families alongside educator professional development to support anti-racist relationship building; however, these additional designs are not reported in depth in this paper.

2006, p. 450, see also Cole & Engeström, 2007). The practices that individuals and communities participate in overtime "'hang together' in patterned ways - constellations - that change across history" (Rogoff et al., 2014, 2014, p. 85). Engagement in these routinized practices mediate human thought (cognition), giving rise to heterogeneous and culturally-nuanced knowledges and knowledge systems (Bang et al., 2010) - that is epistemic practices. Learning then, may be considered a cultural accomplishment as individuals take up, resist, and shift particular practices as they navigate the varied cultural communities and contexts of daily life (Banks et al., 2007; Nasir et al., 2006; Nasir et al., 2020; National Academies of Sciences, Engineering, and Medicine, 2018) to achieve desired goals (Engeström, 2001). It is therefore the goal-directed activity or interconnected systems of activity that become the unit of analysis for exploring and designing for human learning (Nasir & Hand, 2006).

This conception of learning and activity as culturally mediated expands our understanding of disciplinary activity as also cultural. Scientific disciplinary activity, from sociocultural views, is a robust - although not uncontested - constellation of practices, organized around routinized ways of knowing, doing, and being, shifting across history and across cultural communities (Lee, 2008; Bell et al., 2012; Warren et al., 2020). As such scientific activity is also shaped by particular axiological and ontological positionings that shape disciplinary knowing and learning. Arguably, science education has largely been shaped by settler colonial axio-onto-epistemologies that operate to perpetuate hierarchical and powered relations between Western and nondominant knowledge systems (Bang et al., 2012; Bang & Marin, 2015; Cajete, 2000); however, there is growing praxis-oriented scholarship that seeks to design new learning environments predicated on relationality, dignity, and just possible futures as "elsewheres" to settler futurity (e.g., Bang & Vossoughi, 2016; Esmonde & Booker, 2016; Espinoza & Vossoughi, 2014; Gutiérrez & Jurow, 2016).

The study described in this paper builds upon and extends this justice-oriented work to envision science learning as expansive - "an activity in which heterogeneous meaning-making practices come into contact - explicitly and implicitly, intentionally and emergently - to generate new understandings, extend navigational possibilities, and adapt meaning-making practices to new forms and functions" (Rosebery et

al., 2010; p. 324). Further, we envision an expansive view of scientific disciplinary activity as one that is consequential to students, families, communities, *and places*. Families are the heart of such work (Bang et al., 2018b), and as such play a central role in imagining, designing, and enacting such expansive learning (Ishimaru et al., 2018). We understand this to mean learning as an act of transformative possibility for individuals and collectives (Gutiérrez & Vossoughi, 2010), and science learning as a way to responsively make sense of and transform pressing socio-ecological challenges to individual and collective wellbeing.

Learning as Contextually Mediated by Places, Lands, & Waters. Goal directed activities are contextually bound, and as such context plays an important role in shaping both the cultural practices in which communities engage and the knowledge and knowledge systems of these contexts (Atran & Medin, 2008; Bang, 2015; Brown et al., 1989; Nasir & Hand, 2006). This has been broadly explored as the semiotic resources afforded in particular bounded spaces that structure attention of individuals in joint activity. For example, Charles Goodwin (2000) illustrates how sensemaking in activity is co-constructed between girls playing hopscotch on a playground using gestural and linguistic markers in reference to the hopscotch grid. The activity exists within a contextually bound and shared space - a playground - which structures the shared purpose of activity and is culturally imbued with historicized activity.

Additionally, the semiotic resources of the more-than-human world, including lands, waters, and more-than-humans, shapes cognition in unfolding activity (e.g., Atran et al., 2005; Bang et al., 2014; Marin, 2013; Marin et al., 2017; Pugh, 2019). For example, young Indigenous learners are "apprenticed" into epistemic practices that facilitate learning with and from more-than-human others[8] through familial and designed learning opportunities (Pugh et al., 2019, p. 424; see also Bang et al., 2014). Such place-emergent epistemic practices have been shown to support complex systems learning and decision-making, supportive of consequential and expansive science learning (Atran et al., 2005; Bang et al., 2014; Montaño Nolan, 2016; Pugh, 2019). However, Bang & Marin (2015) contend that the oversaturation of

[8] "More-than-human others" refers to non-human biological and abiological kinds. This terminology is meant to de-center conceptions of human dominance in social and ecological systems and refuse binary relations between living and non-living things.

human-centered learning environments in designed formal and informal learning environments (i.e., indoors) may contribute to both the difficulty in learning about complex ecological systems (and therefore making decisions about systems) as well as disproportionate disengagement in STEM learning of Indigenous and nondominant learners. For this reason, we intentionally take up a land-based design politic whereby learning is consequential to human-communities as well as lands, waters, and more-than-humans (Calderon, 2014; Bang et al., 2014; Simpson, 2014).

Learning as Mediated by Tools and Artifacts in Goal Directed Activity. Finally, such epistemic activities are mediated by cultural tools (e.g., language, concepts, etc. and material artifacts (e.g., worksheets, devices, objects, etc. (Vygotsky, 1962; Engeström, 2001). These tools are shaped by the cultural-historical context and use in which they emerge, as well as shape the goal-directed activity of the users (Cole & Engeström, 2007). Over time, use of these mediational tools organizes and structures cognition. Individuals may re-mediate particular tools in service of goals beyond or in contrast to their cultural and historical intention or use (Gutiérrez & Vossoughi, 2010). For example, as I discuss later in this paper, the FKPS tools were designed to facilitate equitable home-school relations by centering familial knowledges and practices as consequential to science learning. This was a conscious re-mediation on our part as homework has a cultural and historical use as a dominant insertion of school-based practice into home-life. Thus, designing mediational tools that facilitate expansive science learning and support heterogenous ways of knowing, being, and doing is a core design necessity (Bang et al., 2016).

4.2.2. *Conceptual Grounding: Our Core Design Propositions*

Guided by these theories, our conceptual framework, which we refer to as a rhizome undergirds the objectives of the co-design process and model development. I describe each of these briefly here and then illustrate them more in-depth in the design analysis section. Our rhizome builds upon the notion of the germ cell in formative interventions (Sannino et al., 2016) as well as rhizomatic analysis (e.g., Deleuze & Guattari, 1987; Leander & Rowe, 2006) as the blue print for our designs (Bang et al., in prep.).

Nature-Culture Relations and Power & Historicity. Nature-culture relations have been explored in science education and characterize how nature and culture are considered entwined and mutually

constituted (nature-culture relations), or separate and unequal (nature/culture divides) (e.g., Bang & Marin, 2015; Bang et al., 2012). How we construct nature-culture relations implicates how we value the particular practices of science, decisions that we make regarding socio-ecological systems, and how we might resource learning about/with phenomena. Epistemic practices such as reading and walking the land, engaging in storywork, perspective taking, and inviting multivoiced meanings and explanations of phenomenon (among many others) have been shown to facilitate reciprocal nature-culture relations in designed informal and formal learning environments as well as complex systems sensemaking (Bang & Marin, 2015; Bang et al., 2012; Montaño Nolan, 2019; Pugh et al., 2019). The kinds of nature-culture relations refracted in formal science learning environments typically privilege constructions of humans above or outside of natural systems (i.e., human supremacy and exceptionalism) (Bang & Marin, 2015; Medin & Bang, 2014a). For all young people, this construction limits axio-onto-epistemic relationality with the natural world, especially for Indigenous and non-dominant students. Our project seeks to facilitate nature-culture complementaries through designs that visiblize human interactions and decisions with the natural world as laden with cultural values, aesthetics, and powered dynamics *and* (re)make healthful relations.

Complex Socio-Ecological Systems. Understanding ever-changing relations and impacts to our social and natural world at both the individual and societal levels as well as local and global levels is a grand challenge of our time (Bang et al., 2016; Berkes, 2017; Yoon & Hmelo-Silver, 2017). Complex systems are defined by the relationships and predictable causal patterns of components within larger macrosystems, as well as changes within these systems over time, which can make sensemaking challenging for students (Hmelo-Silver & Azevedo, 2006; Hayes et al., 2017). Being able to make sense of interactions and patterns across multiple scales - including temporal, spatial, and agent-aggregate - is a foundational to systems learning and decision-making and recognized in the Next Generation Science Standards (NRC, 2012; Yoon & Hmelo-Silver, 2017). A core challenge of systems learning has been the over-emphasis in science education of taxonomic memorization of subcomponents within a system (i.e., naming identifiable parts within a system) without attending to the patterned interactions and

relationships within the systems (Marin et al., 2017; Medin et al., 2014). Additionally, conceptualizations of human-absence from- or human-harm in ecological systems forecloses sensemaking about possible human ethical relationships with more-than-human others and lands and waters (Pugh et al., 2019) and possibilities for expansive science learning, particularly for Indigenous and nondominant students.

In our expansive science model, we conjecture that learners need to be apprenticed into noticing and sensemaking across five core dimensions of socio-ecological systems: (a) species, kinds, and behaviors; (b) relationships; (c) places, lands, and waters; (d) thinking across scales (temporal, spatial, and agent-aggregate); and (e) human decision-making (Bang et al., in prep.). This project deliberately designed for each of these five dimensions of complex socio-ecological systems sensemaking through the design of mediational tools to facilitate such sensemaking during engagement in field-based science activities.

***Field-Based Science*.** The project takes field-based science as foundational to making learning consequential to students and families, and authentic to what scientists do (Eberbach & Crowley, 2009). In particular, I highlight two core field-based practices as critical for supporting reciprocal nature-culture relations and complex systems learning: observing and question asking. Observing is a culturally-mediated sensemaking practice that frames which features and relationships in a given context are salient for sensemaking and decision-making (Bang et al, 2016; Marin, 2013). All cultural communities engage in observing in sophisticated ways (Bang & Marin, 2015; Rogoff et al., 2014); *scientific* observations are a particular practice within scientific communities that reflect disciplinary attention to understanding and explaining phenomenon. Eberbach and Crowley (2009) write, "Learning to observe scientifically is clearly much more than acquiring a perceptual skill—it is an act of joining a scientific community that uses observation to argue about the fundamental organization of nature" (p. 58). In our model, we understand observation as a practice of science that helps us argue about the fundamental nature of socio-ecological systems through systematic and disciplined noticing, wondering, and collecting data about phenomena located in places.

Asking questions is the cornerstone of scientific activity. Understanding and explaining socio-ecological phenomena begins with questions that arise from personal and professional curiosity or the need to solve particular problems (NRC, 2012). However, asking questions is neither a neutral nor straightforward practice, but entangled in conceptions about what can be known and how it is organized - that is epistemic orientations. For example, Bang and colleagues (2012) explore how the question "what is life" - arguably a fundamental question of the life sciences - can open up or eclipse possible heterogeneous sensemaking in classrooms as students and educators grapple with what it means to know life from differing nature-culture orientations. The student in their example, considered life from a relational perspective, reasoning that sunlight is a part of the natural cycle of living things and therefore living in its own right, while the educator and fellow student positioned sunlight into the normative non-living category. This moment was an opportunity for generative meaning-making across axio-ontological claims to knowledge about the nature of living things; however, only a singular "correct" answer was sought, thus foreclosing possible expansive meaning-making. We see learning to both ask and refine generative questions that emerge from students' and families' place-based curiosity as well as grapple with the complexity and multiplicity of possible meanings to the question a critical to equitable science activity. Drawing from land-based pedagogies (Simpson, 2014) and studies designing for complex systems learning within Indigenous communities (Bang et al., 2016; Barajas-López & Bang, 2018; Pugh et al., 2019), we argue that engaging in field-based science practices that facilitate reciprocal nature-culture relations can support expansive socio-ecological complex systems learning.

These core propositions seek to tie heterogeneous familial knowledges and practices within disciplinary activity, intentionally connecting learning between homes and schools, and emplacing learning in ways that matter to families and communities. Further, these design propositions grow horizontally across each aspect of our project, giving familiar shape and form to each design while also enabling new growth in unanticipated ways. In the next section, I describe how these core propositions were instantiated in the design of our science model more broadly, and concretized in activity and tool design.

4.3. DESIGN METHODOLOGY

This study was part of a larger NSF-funded project, *Learning in Places*, that utilizes participatory design research (Bang et al., 2016; Bang & Vossoughi, 2016; Ishimaru et al., 2018) to co-design expansive science learning with families, educators, community organizations, and researchers. Informed by design based research (e.g., Bell, 2004; Design Based Research Collaborative, 2003) and drawing explicitly upon decolonizing methodologies (Smith, 2013), community based design research seeks to advance theories of culturally mediated forms of human learning as well as the creation of learning environments that contribute to community thriving (Bang et al., 2016). Participatory design research further articulates and addresses asymmetrical and historically accumulated power dynamics within co-design processes (Bang & Vossoughi, 2016).

The purpose of co-design in this project was multifaceted including three interrelated strands of work: (a) the development of a field-based science model for complex socio-ecological systems learning that spans classrooms, neighborhoods, and local greenspaces; (b) development of an equitable family engagement model that supports family and community learning and decision-making; and (c) development of a model for collaborative research partnerships with families, communities, and education systems that addresses power, historicity, and relationality in processes of partnering (Bang et al., in prep.). Each dimension of design was further refined and specified. For example, the co-design of an equitable family engagement model included design of outdoor learning gardens in school yards building on the interests and needs of families, out-of-school and summer programing with families, and family knowledge and practice sharing activities that re-configured science learning across home and school. For this paper, I focus on the family knowledge and practice sharing activities and tools.

4.3.1. *Co-design Process*

The co-design process included teams of University-based researchers, K-3 educators and families, district science specialists, and community organizations with a specialty in outdoor education. The core research team took lead on (a) designing the overall structure and first drafts of curricular materials, pedagogical practices, and facilitating co-design with other teams; (b) identifying and creating

professional learning opportunities for educators, families, and district staff in content domains (e.g., equity in family engagement, anti-racist pedagogy, NGSS, phenology, complex systems, etc.; and (c) data collection, analysis, and knowledge dissemination to support data-informed decision making throughout the co-design process. The core research team included faculty and graduate researchers from two Universities, a nonprofit community organization with expertise in school-based garden design and education, and school district science specialists.

Four leadership schools and a coalition of community organizations with expertise in outdoor education participated in designing, implementing, evaluating, and revising the model (and all materials/practices). For the purpose of this paper, I focus on two leadership schools (Creekside Elementary and Parkview Dual Language Immersion School) that participated in implementation of the model, including the FKPS tools[9]. Co-design teams within the schools included K-3 educators and families. Educators within each school were self-selected based on interest in improving outdoor science education, completion of district-led NGSS training, and motivation/energy for the intensity of co-design work. Families joined co-design teams either through individual invitation from participating educators or through learning about the project from flyers, informational nights, and relationship building from the core research team who attended school and community events, learned about and connected to existing family networks, etc. Some families joined co-design leadership teams as ongoing collaborators, some participated in specific co-design sessions, and others joined an afterschool program that was created to support a diversity of family collaboration opportunities.

Co-design occurred through a variety of formats including seasonal summits, monthly co-design sessions, and informal touchpoints with teachers as they implemented the seasonal storyline (e.g., phone calls, emails, after classroom implementation, etc., as well as weekly research team meetings (**Appendix 4A** describes the co-design process in relation to tool development). Seasonal summits were one-to-five-day long gatherings with all co-design teams to design, make sense of, and iterate upon the expansive

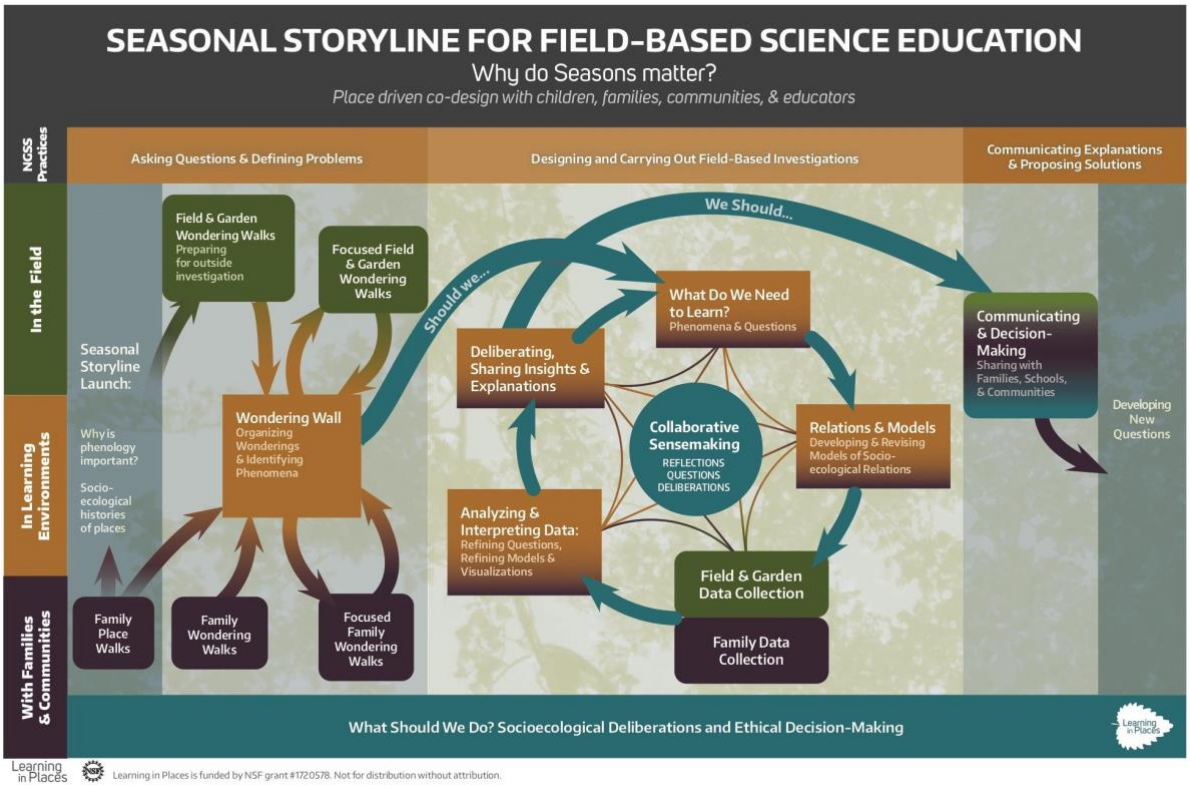
9 The other two schools co-designed in year one of the project, but did not participate in implementation or co-design beyond year 1.

science activities. Co-design sessions were two-hour long meetings, held monthly at each leadership school to focus on design and implementation of the storyline for each classroom, as well as inform the full design of the model. Weekly research/design team meetings were devoted to designing both the co-design process (i.e., content and processes of summits/design sessions) as well as the concrete activity systems of the science model.

4.3.2. *A Seasonal Storyline for Field Based Science Education*

Building from the work of sociocultural and cultural historical theorists, we utilized an activity systems approach to designing a seasonal field-based science model for learning about place-based socio-ecological phenomena, building with the three core concepts described above. The model takes the form of a science storyline (Schwarz et al., 2017), which leads a classroom through a full investigation cycle over the course of a school year. **Figure 4-1** represents the sequence of activity systems that span the year and occur with families and communities, in the classroom, and in the field. Science storylines provide a useful heuristic for organizing and sequencing the progression of key concepts and practices of scientific inquiry (Hanuscin et al., 2016). While many science storylines predetermine the disciplinary concepts that students learn in the form of a thematic unit (i.e., water cycle, land forms, butterfly life cycles/metamorphosis, etc.), our storyline is organized around engaging students in the central field-based practices of scientists across schools and neighborhoods and supporting attentional habits towards the five dimensions of socio-ecological sensemaking as they engage in these practices. Each classroom investigation uniquely emerges from place-based observations and wonderings. We use phenology - the study of seasons and their impacts on socio-ecological systems - as a lens to attune field investigations to patterns of social and natural phenomena over time and across places. Attending to seasonal patterns also engenders heterogeneous sensemaking about climatic changes affecting the interdependence of species and aligns with several NGSS disciplinary core ideas (DCI) and cross cutting concepts (CCC) across grade bands. Additionally, we provided professional development resources (i.e., conceptual frameworks, lesson plans, PD with field scientists etc. to make visible the aligned NGSS disciplinary core ideas and performance expectations emergent in classroom investigations at each grade band.

Figure 4-1 Storyline diagram of seasonal field-based science education



The storyline features ten activity systems, which we refer to as *learning engagements*, that each culminate in a learning target that propels learning through the storyline. Each learning engagement contains a series of smaller activities - or lessons - that build upon one another, working towards the goal of the learning engagement. Each activity can be repeated until the learning target is accomplished, or revisited later as additional questions are asked or more data is needed as part of the investigation. Broadly, these ten learning engagements are divided into three major phases of the storyline that correspond to NGSS aligned practices: asking questions and defining problems, designing and carrying out field-based investigations, and communicating explanations and proposing solutions (orange columns on the top of the figure). Along the left, the rows in green, orange, and purple indicate the context in which these activities take place: in the field, in the classroom, and with family and community (respectively).

4.3.3. *Storyline Mediational Activities and Tools*

Each activity in the storyline is organized around engagement in a goal-directed object that ultimately leads towards expansive learning about socio-ecological phenomena. Articulating the object of each activity highlights how each activity builds upon and extends the ideas of learners over time. Each activity is mediated by a tool, or set of tools that support scientific sensemaking. We developed two primary modes of tool-mediated activity, (a) discursive and reflective indoor activity/tools, and (b) attentional, mobile, and discursive outdoor activity/tools. These include material tools such as worksheets that coordinate activity across outdoor and indoor learning settings as well as individual and collective sensemaking. For example, a wondering walk tool is completed individually by children while observing outdoors and then used for collective sensemaking back in the classroom as groups of children compared and contrasted their noticings. Teacher tools were created to hold the complexity of multivoiced activity (Engeström, 2001) and support teachers in making pedagogical choices about how to progress through the storyline. Additionally, some tools are dialogic, supporting routine discourse habits in the field and in the classroom for collective sensemaking, such as observing, questioning, connecting to family knowledges/practices, etc.

The family knowledge and practice sharing tools are one such mediational tool created to support expansive science learning by asking families to engage in a science activity as homework. These tools were designed first and foremost as extended conversation pieces, inviting families to share their perspectives, knowledges, and practices in ways that would be integrated into classroom learning over time. This meant the tool needed to be designed and implemented in a way that facilitated use of the tool as meaningful work, rather than a transactional object to be completed by child and turned in for a grade or participation (Nolen et al., 2020).

Increasingly, families are expected to supplement school-based learning through homework help, catching students up on concepts they did not learn in schools, either because of perceived faults in the child or perceived lack of time in the school day. Critics of this supplemental model contend that this places undue burden and blame on families (Baquedano-López et al., 2013). Further it elides critique of

systemic inequities such as resource allocation, educator professional expertise, and expectations that disproportionately affect families and communities from minoritized communities (Nakagawa, 2011). In other words, these tools were designed to disrupt any unidirectional flows of information (either school-to-home, or home-to-school), and instead facilitate reciprocal relationality between home and school science learning. Rather than student academic achievement being the center of activity, in our designs, familial wellbeing and interests drove the activity and encouraged intergenerational learning from parents and extended family members.

For this paper, I focus analysis on the first phase of the investigation: asking questions and defining problems in order to illustrate how we designed for place-based investigations that build with familial knowledges and practices. This phase of the storyline includes Learning Engagements 1 - 4, culminating in a robust data set of seasonal observations of socio-ecological phenomena, place-emergent questions for investigation, and routine sensemaking habits spanning indoor and outdoor spaces across homes and schools. I briefly describe the design objectives and sequencing of these learning engagements in this section and detail the particular FKPS activities and tools in the design analysis section of the paper.

4.3.4. *Overview of Storyline Activity Systems: Asking Questions and Defining Problems Learning Engagements*

Learning Engagement 1: Co-Defining Places and Seasons. The storyline launches with activities designed to scaffold students' attention to places and seasons - and the interrelations of human and more-than-human others - as meaningful for scientific study. The shared objective for the entire learning engagement (collective system of activities) is to create classroom collective definitions of places and seasons based in individual and familial stories, scaffolded observation of seasonal markers (i.e., temperature, plant phenology, animal behaviors, etc., and lessons on disciplinary conceptions of place and seasons (i.e., planetary rotation, solar system). Two FKPS activities and mediational tools were created to support these learning objectives: Learning Engagement 1.3 Learning Across Places tool [LE 1.3: FAMILY PLACES] and Learning Engagement 1.8 Why is This Season Important to Our Families [LE

1.8: FAMILY SEASONS]. LE 1.8 Family Seasons has not gone through two rounds of implementation and iteration and was not included in this analysis (see Design Data Analyzed section).

Learning Engagement 2: Observing and Asking Questions in Places. The second learning engagement focuses on building field-based attentional habits, or observational practices (Eberbach & Crowely, 2009), during walks around schools and neighborhoods in order to discipline outdoor perception of complex systems components and relationships (i.e., what we notice and how they relate to one another). Additionally, a core goal of this series of activities was to generate a robust set of observations and questions that informs classroom investigations that could be conducted across places. Students ask and refine place-based questions individually, in small groups (in classroom and in families), and as a whole classroom. These activities could (and were) repeated multiple times until themes emerged as potential phenomena for further place-based exploration. One FKPS tool was designed to connect these wonderings across places: Family Wondering Walk 1 (LE 2.4 WONDERING WALK 1).

Learning Engagement 3: Organizing Noticings and Wonderings into Phenomena Themes. The third learning engagement is conducted in the classroom as students engage in activities that organize their noticings and wonderings into potential phenomena themes that could be investigated over the year. Additionally, they engage in lessons about core relationships in socio-ecological systems as a way to refine their noticings and wonderings and organize them in ways that make visible interactions among components of a system. There are not currently storyline family knowledge and practice sharing tools designed for this learning engagement.

Learning Engagement 4: Focused Observations of Phenomena Across Places. Learning Engagement 4 builds upon and extends the focus on relational phenomena as students engage in a series of activities in which they study a phenomena, identified in Learning Engagement 3 from the wondering walks in Learning Engagement 2, building on their conceptions of seasons and places in Learning Engagement 1. Core objectives include learning increasingly sophisticated observational habits as students observe phenomena across a range of spatial and temporal dimensions, predicting and modeling interactions between components of complex systems observed, and comparing and contrasting

observations through scientific discussion in small groups and whole group. One FKPS tool was designed to support these learning targets: Learning Engagement 4.4 Family Wondering Walk 2 (LE 4.4 WONDERING WALK 2).

4.4. DESIGN DATA ANALYZED

4.4.1. *Context*

Co-design of the FKPS tools began in winter through spring 2018 following the winter 2018 launch of our co-design process with three leadership schools in an urban district in the Pacific Northwest: Creekside Elementary, Mountain View Elementary, and Lighthouse Language School. All three schools were selected by the district science specialists, meeting several criteria including: (a) having K-3 teachers who completed NGSS alignment training, provided by the district; (b) representative of diverse student populations, as recognized by Title 1 status, racial/ethnic makeup, proportion of students receiving free-and-reduced lunch meals, and proportion of students receiving bilingual services; and (c) having existing relationships with principals and staff, cultivated through ongoing partnership at the district-level. In year 2 of the project (AY 2018-2019), Parkview Dual Language Immersion school joined as a leadership school. Given a literacy adoption and increased other demands, teachers at Mountain View and Lighthouse Language School opted to become scale schools for the next phase of design. Both Lighthouse and Parkview are dual Spanish and Mandarin language immersion schools. I describe Creekside Elementary and Parkview Dual Language Immersion school in more depth as K-3 classrooms in these schools implemented FKPS tools.

Creekside Elementary school serves grades K-5. The elementary school borders a 200-acre park, Arroyo Park, featuring multiple natural and human-managed ecosystems including forest, riparian, wetlands, intertidal beach, and an apple orchard. The creek is the site of major restoration in recent decades, recovering the salmon run/spawning grounds and increasing biodiversity in the forest and wetlands. Prior to the project, educators at Creekside engaged in semi-routine walks to view the salmon runs (October-December), or to the orchard or beach. However, educators wanted more support in engaging young children in outdoor learning and making the walks more connected to science learning

(field notes, January 2017 summit). The Learning in Places field-based seasonal science model built upon the semi-routinized practices of outdoor walks that teachers were already doing with students and intentionally scaffolded field-based science practices, such as observing and asking questions during these walks. Additionally, the school features three raised garden beds and is managed by a family member, Casey, who facilitates classroom planting, harvesting, and learning in the garden with any interested classrooms. Casey is a family co-design leader as part of the project and facilitates both classroom (indoor and outdoor) storyline activities as well as out-of-school family programming as part of the project.

When research team members began building relationships with schools in 2015, Creekside was Title 1 designated with nearly 58% of students receiving free-and-reduced lunch, and 28% bilingual services. Shifting demographics, however, have changed the diversity landscape of the school and it has since lost Title 1 designation. The school is predominantly White (50.7%) and Hispanic/Latino (15.4%,) (Black 10.2%, Asian 8.6%; Native[10] 1.5%; two+ races 13.6%) (district website).

Parkview Dual Immersion School is a choice enrollment school serving K-5 students. The school borders a 4.5-acre city park that features deciduous forest, wetlands, and public greenspaces and playgrounds. Within walking distance of the school are a major pedestrian/biking trail running north-south through the city as well as a green belt that hosts City Lights towers for the neighborhoods. Residents in the neighborhood have a community garden in the green swath under one of the towers. Paths to/from the school into neighborhoods are carved into the park through routine use by students and families. Additionally, the school has raised garden beds in the courtyard that were built and managed as part of a past research-school partnership focused on garden and health education. The partnership ended and care of the garden fell to a 4th grade teacher and veteran parents involved in the project. Additionally, Parkview has a history of family engagement managing the wetlands and forest areas near the school; however, overgrowth of invasive species (i.e., blackberry, morning glory, and knotweed) prevented classrooms from accessing the wetland. Although not detailed here, the out-of-school family programs

[10] Native includes American Indian, Alaskan Native, Native Hawai'ian, and Pacific Islander.

co-designed in this project sought to clear and reclaim the wetlands as a site for outdoor classroom learning.

Parkview is a Title 1 school with majority nondominant students (39.5% Asian, 24.8% Black/African American, 14.4% two+ races, 10.7% Hispanic/Latino, 10.4% White, 0.3% Native) (district website). The choice school features dual language immersion in tracked Spanish or Mandarin. Students receive math and science in their selected language with a morning or afternoon educator, and all other subjects in English with a different educator. Educators are grade banded K-1st or 2nd-3rd and teach one grade in the morning and the other in the afternoon.

4.4.2. *Data Analyzed*

Data for design and content analysis includes FKPS tools from learning engagements one, two, and four of the seasonal storyline, as of January 2020 (n = 58 tools). For this analysis, I focus on three tool-mediated activities that seek to elicit place-based knowledge and practices from students and families as well as launching aspects of our core concepts that are built upon during later learning engagements. These include activities titled Learning Engagement 1.3: Learning Across Places, Learning Engagement 2.2 Wondering Walk 1, and Learning Engagement 2.4 Wondering Walk 2.[11] These FKPS activities and tools were sampled for this analysis because (a) these tools, and the activity systems they were designed to support, have gone through at least two full cycles of co-design (design, implementation, evaluation, and re-design); and (b) the design characteristics have stabilized, requiring only classroom-specific adaptations. Further, these activities elicited both indoor and outdoor learning opportunities for families. A core facet of this analysis is understanding the affordances and constraints of engaging in expansive science learning indoors and outdoors.

[11] In the title for each tool-mediated activity, the first number refers to the learning engagement (activity system), the second number to the sequence in which we designed for activities to be conducted. For example, LE 1.3 would come after two previous learning activities (LE 1.1, histories of places classroom discussions; LE 1.2 school yard walk). The sequence of activities were pedagogical suggestions; however, educators used their professional expertise to ultimately determine when and where to implement each activity.

Table 4-1 shows the number of each tool by version, which I describe in more depth in the next section. In this analysis, I do not disaggregate data by classroom or grade band as we do not have enough completed/consented tools per classroom to make claims from the data, however such an analysis is planned for the future. 48 total families are represented in this analysis. 41 families completed one tool, four families completed two tools, and three families completed three tools. All tools were deidentified for analysis. Black text boxes covered student names or identifiable material on images. Students were assigned a letter or combination of letters (A, AB, etc. to connect student work across the storyline and across years of implementation. Demographic data were not collected from families; however, preliminary analysis of classroom implementation suggests that many of the families identify as immigrants, descendants of immigrants, or people of color.

All family tools in this analysis were sent home in English. However, the final version of all tools are translated into Spanish and Mandarin. Further language translations may happen in the future. The research team is currently exploring technology solutions that would expand language possibilities so as to encourage families' use of home languages with their children as part of school-based practice and disciplinary learning, and to facilitate socio-ecological deliberation and decision-making in a preferred language.

Table 4-1 Number of completed FKPS tools by version

	Learning Engagement 1.3: Learning Across Places		**Learning Engagement 2.2: Wondering Walk 1**		**Learning Engagement 4.4: Wondering Walk 2**	
	Version 1	Version 2	Version 2	Version 3	Version 1	Version 2
Number of Tools	12	17	10	10	2	7

In the remainder of this paper, I conduct two types of analysis on these three selected FKPS tools. The first is a design analysis that articulates our conjectures for reconfiguring home-school relations utilizing the FKPS tools, particularly in relation to our three core concepts. Secondly, I conduct a content analysis on the implemented FKPS tools, focusing on the five dimensions of socio-ecological complex

systems in relation to nature-culture relations and the field-based science practices of observing and asking questions.

4.5. ANALYSIS 1: TOOL-MEDIATED DESIGN OBJECTIVES & CHARACTERISTICS OF FKPS TOOLS

It is the purpose of this first analysis to begin articulating a response to my first design research question, *How can homework tools re-configure boundaries between home-school relations, knowledges, and practices related to expansive field-based science learning?* In this section I describe how we envisioned our core concepts manifesting in and through our co-design of these mediational activities and tools.

4.5.1. *LE 1.3 Learning Across Places*

Designed as an indoor family discussion between a student and their family, LE 1.3 FAMILY PLACES invites families to consider an important place in their lives, describe it, and to consider socio-ecological dimensions of this place. The tool is four pages long and features a drawing/pasting area for families to illustrate their important place, as well as 16 prompts to facilitate discussion with text fields to summarize their conversation. **Figure 4-2** shows the final tool (v2). (See **Appendix 4B** and **Appendix 4C** both version iterations). The shared object of this activity was three-fold: (a) families engage in intergenerational learning through storytelling and drawing; (b) families share stories about places and their importance to their lives and learning; and (c) families share epistemic knowledge related to spatial and temporal socio-ecological complex systems sensemaking that can be integrated in whole classroom sensemaking about learning across places. While we designed with all three core concepts in mind, this activity was explicitly designed to facilitate nature-culture relations and complex socio-ecological systems sensemaking. Further, we recognize and seek to address the powered and historically saturated dynamics at work across activities and activity systems.

The storyline begins with familial stories of important places in order to catalyze a shift in home-school relations for expansive science learning. Building from Indigenous knowledge systems (Brayboy 2005; Cajete, 2000; Kovach, 2009), particularly the work of Jo-Ann Archibald (2008) we argue beginning

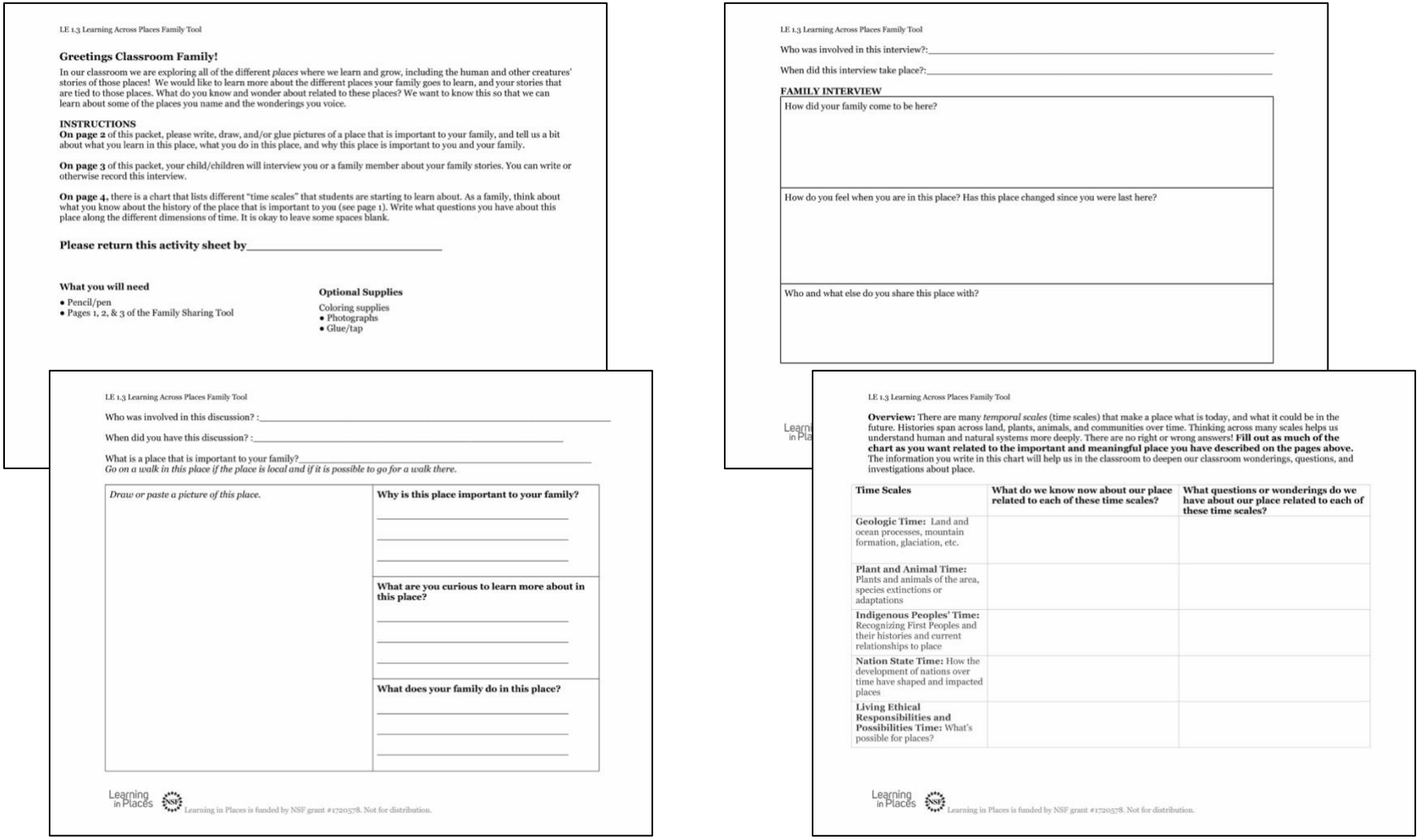
with and privileging storytelling as the entry-point to scientific activity re-mediates science to the everyday and expert practices and knowledges of families and communities (Bang et al., 2012; Marin & Bang, 2018; Warren et al., 2001). Furthermore, storytelling, as a joint activity, can support intergenerational learning and robust scientific engagement in culturally thriving ways (Marin & Bang, 2018; Montaño Nolan, 2019; Tzou et al., 2019).

In order to elicit reciprocal nature-culture relations we prompted families to consider more-than-human others in the telling of their stories through explicit prompts such as "who and what do you share this place with" (page 3 of tool) as well as reasoning about Indigenous peoples, plants, animals, and future ethical possibilities (page 4 of tool). In order to elicit complex systems sensemaking, we asked families to reason about their important place across spatial and temporal dimensions. Reasoning about complex systems requires thinking across multiple scales of place (local and global) and time (past, present, and future), as well as rates of change (sudden or climatic change - events; or gradual change that occurs over long periods of time). In order to support spatial reasoning, we asked families to tell their stories of coming to be in their important places - opening space for Indigenous thriving as well as stories of migration and mobility. To support temporal reasoning, we designed a framework for reasoning across several temporal dimensions, which we refer to this as "socio-ecological histories of place" (Bang et al., in prep.; Learning in Places, 2020c). In LE 1.3 FAMILY PLACES, we ask families to consider their important place across each of these dimensions: (a) geologic time; (b) plant and animal time; (c) Indigenous peoples time, (d) nation-state time; and (e) living ethical responsibilities and possibilities time (page 4 of tool).

Re-design of the tool occurred after implementation in September-October 2020 and collective sensemaking during the fall 2020 co-design summit. Importantly, major revisions between versions 1 and 2 centered on conceptual updates to the histories of place framework. Version 1 of this tool used "recent history" and "current history" in place of "nation-state time." This was changed to better reflect the politicized nature of place-making across generations. Further, "future possibilities" in the first version

was revised to “living ethical responsibilities” to better account for the role and responsibilities of humans to these important places.

Figure 4-2 Learning Engagement 1.3 Learning Across Places Family Tool (version 2)



LE 1.3 Learning Across Places Family Tool

Greetings Classroom Family!

In our classroom we are exploring all of the different *places* where we learn and grow, including the human and other creatures' stories of those places! We would like to learn more about the different places your family goes to learn, and your stories that are tied to those places. What do you know and wonder about related to these places? We want to know this so that we can learn about some of the places you name and the wonderings you voice.

INSTRUCTIONS

On page 2 of this packet, please write, draw, and/or glue pictures of a place that is important to your family, and tell us a bit about what you learn in this place, what you do in this place, and why this place is important to you and your family.

On page 3 of this packet, your child/children will interview you or a family member about your family stories. You can write or otherwise record this interview.

On page 4, there is a chart that lists different "time scales" that students are starting to learn about. As a family, think about what you know about the history of the place that is important to you (see page 1). Write what questions you have about this place along the different dimensions of time. It is okay to leave some spaces blank.

Please return this activity sheet by_____

What you will need

- Pencil/pen
- Pages 1, 2, & 3 of the Family Sharing Tool

Optional Supplies

Coloring supplies
- Photographs
- Glue/tap

LE 1.3 Learning Across Places Family Tool

Who was involved in this discussion? :_____

When did you have this discussion? :_____

What is a place that is important to your family?_____
Go on a walk in this place if the place is local and if it is possible to go for a walk there.

Draw or paste a picture of this place.	**Why is this place important to your family?**
	What are you curious to learn more about in this place?
	What does your family do in this place?

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LE 1.3 Learning Across Places Family Tool

Who was involved in this interview?:_____

When did this interview take place?:_____

FAMILY INTERVIEW

How did your family come to be here?
How do you feel when you are in this place? Has this place changed since you were last here?
Who and what else do you share this place with?

LE 1.3 Learning Across Places Family Tool

Overview: There are many *temporal scales* (time scales) that make a place what is today, and what it could be in the future. Histories span across land, plants, animals, and communities over time. Thinking across many scales helps us understand human and natural systems more deeply. There are no right or wrong answers! **Fill out as much of the chart as you want related to the important and meaningful place you have described on the pages above.** The information you write in this chart will help us in the classroom to deepen our classroom wonderings, questions, and investigations about place.

Time Scales	**What do we know now about our place related to each of these time scales?**	**What questions or wonderings do we have about our place related to each of these time scales?**
Geologic Time: Land and ocean processes, mountain formation, glaciation, etc.		
Plant and Animal Time: Plants and animals of the area, species extinctions or adaptations		
Indigenous Peoples' Time: Recognizing First Peoples and their histories and current relationships to place		
Nation State Time: How the development of nations over time have shaped and impacted places		
Living Ethical Responsibilities and Possibilities Time: What's possible for places?		

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Notes. Introduction (top left) frames the goal of the activity and essential materials. Tool Page 1 (bottom left) asks families to think about, draw, and answer questions about an important place. Tool Page 2 (top right) asks families to share their story of coming to be in this place. Tool Page 3 (bottom right) asks families to think about this place across five socio-ecological dimensions of time, including what they already know and what they would like to know.

4.5.2. *LE 2.4 Family Wondering Walk 1*

Learning Engagement 2.4 Family Wondering Walk 1 asks families to go on a walk in their neighborhoods and record and ask questions about what they observe. The tool is two pages long, featuring an introduction to the activity (page 1), a drawing/writing space to record their observation in detail; and two text boxes to write down their noticings and wonderings (page 2). **Figure 4-3** shows the final version of the tool (v3). (See Appendices **4D**, **4E**, and **4F** for all three version iterations). This tool is identical to a wondering walk tool used in the classroom for students to engage in noticing and wondering around the schoolyard and local greenspaces within walking distance. Our design goal was to facilitate students' disciplinary activity in homes and schools as a way to re-configure home-school relations. In other words, the tool was designed as a boundary object (Akkerman & Bakker, 2011) that mediated scientific practice across places.

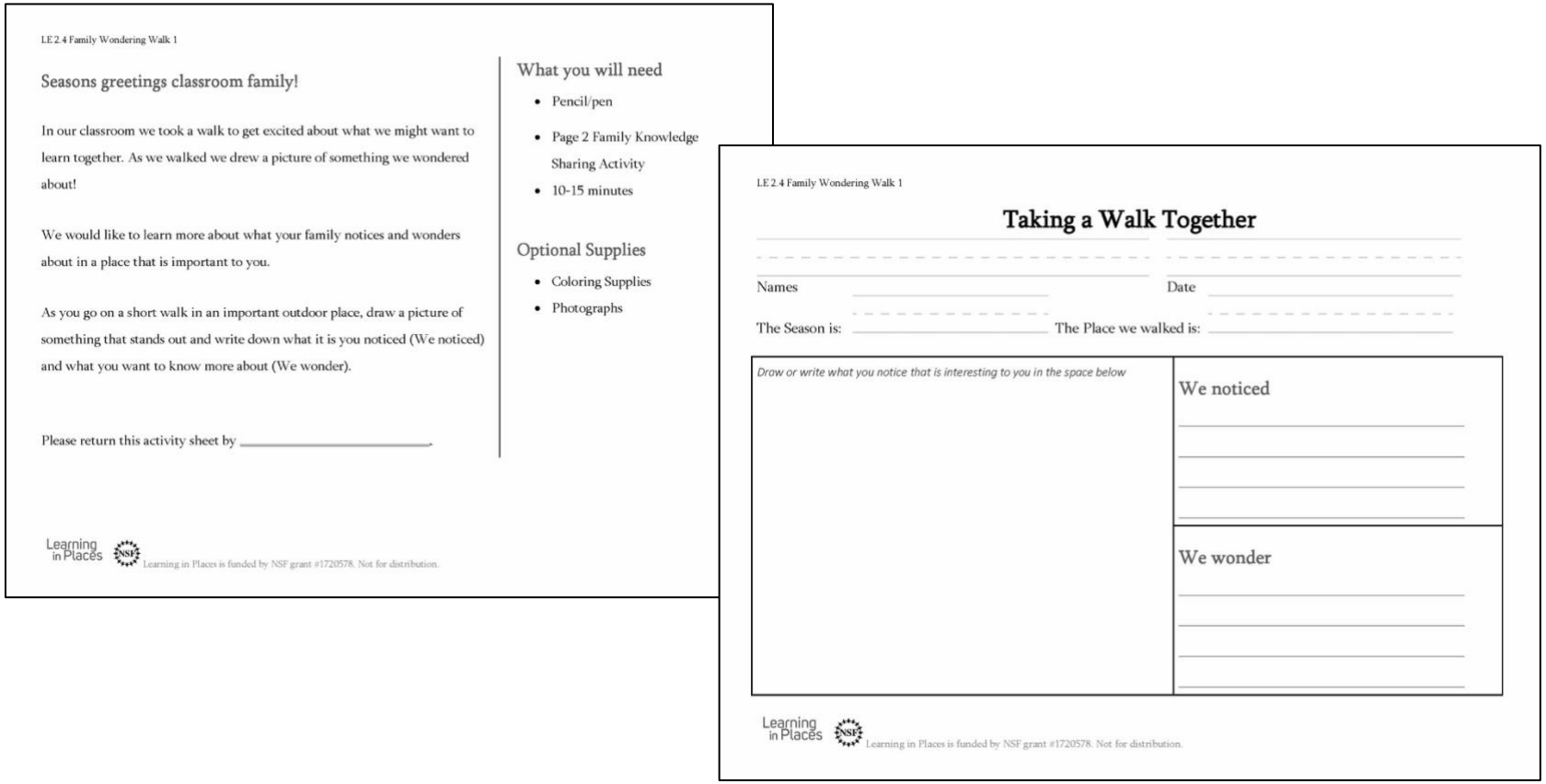
The shared goal of this activity was twofold. First, families go for a neighborhood walk to notice and wonder about what they observe, and second, families share their curiosity and interest in outdoor phenomena with classrooms to impact the seasonal storyline investigation. Specifically, this tool is designed to facilitate complex systems sensemaking through participation in a field-based science epistemic practice. As the first outdoor activity, LE 2.4 was designed to facilitate high leverage outdoor practices such as walking the land, noticing place-emergent phenomena, and asking questions. The drawing space was provided so that the activity could be accomplished by learners with varying writing proficiency, and because drawings have been shown to support children's sensemaking of complex phenomena beyond their writing capabilities (Danish & Enyedi, 2007). The terms "noticing" and "wondering" were chosen to indicate in everyday activity that families already do, and as potential precursors to more disciplinary activity such as scientific observations and asking investigation questions (Sherry-Wagner et al., in prep.).

There were three iterations of this tool. Version 1 was piloted with educators, families, and community organization representatives as part of the spring 2018 co-design summit (see participatory design methodology above and **Appendix 4A**), but was not implemented in any classrooms. As such it is

not represented in the data analyzed. Version 2 was implemented in academic year 2018-2019 in one second grade classroom at Creekside Elementary school, and Version 3 was implemented across classrooms in both schools. Modifications across versions were generally stylistic, focusing on page orientation and layout (horizontal or vertical), with two conceptually driven re-designs. Version 1 included definitions about scientific concepts such as phenology, and tips for families, such as encouraging use of all five senses and asking questions. Based on feedback from educators and families, this tool was revised to more closely reflect family everyday expertise rather than center scientific definitions (although we do not see the two are not mutually exclusive). Instead, these big ideas were woven throughout other FKPS tools later in the storyline as well as in other mediational tools co-designed for families but not yet implemented (i.e. conceptual frameworks for families).

Secondly, after preliminary analysis (using the coding scheme described in content analysis procedures section below) of families knowledges and practices in use of the tool (i.e., implementation) and collective sensemaking of these findings in the spring 2019 summit, we added attentional directives to indicate the place and season where/when walks occurred in order to better facilitate place-based and phenological noticings as well as support teachers' use of the tools in classroom sensemaking. We concluded that being able to track where and when data were collected across the classroom would be important for later explanatory sensemaking across temporal and spatial scale

Figure 4-3 Learning Engagement 2.4 Wondering Walk 1 Family Tool (version 3)



LE 2.4 Family Wondering Walk 1

Seasons greetings classroom family!

In our classroom we took a walk to get excited about what we might want to learn together. As we walked we drew a picture of something we wondered about!

We would like to learn more about what your family notices and wonders about in a place that is important to you.

As you go on a short walk in an important outdoor place, draw a picture of something that stands out and write down what it is you noticed (We noticed) and what you want to know more about (We wonder).

Please return this activity sheet by _____.

What you will need

- Pencil/pen
- Page 2 Family Knowledge Sharing Activity
- 10-15 minutes

Optional Supplies

- Coloring Supplies
- Photographs

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LE 2.4 Family Wondering Walk 1

Taking a Walk Together

Names _____ Date _____

The Season is: _____ The Place we walked is: _____

Draw or write what you notice that is interesting to you in the space below

We noticed

We wonder

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Notes. Introduction (above left) frames the goals of the activity and essential materials. Tool Page 1 (above right) asks families to record their observations as they go on their neighborhood walk.

4.5.3. *LE 4.4 Family Wondering Walk 2*

Similar to the first wondering walk, Learning Engagement 4.4: WONDERING WALK 2 asked families to go on a neighborhood walk and notice and wonder, this time with increased mediational scaffolding to notice relational phenomena across spatial scales as well as collect phenological data (weather, seasons, temperature). This tool is three pages. **Figure 4-4** shows the final version of the tool (v2). See **Appendices 4G and 4H** for both version iterations). The first page introduces the activity and necessary materials, the second features space for families to make predictions about what they will observe, draw their observation attending to spatial directives on the page, and collect data. The third page features a large space for families to write down wondering questions and any other important details of their wondering walk.

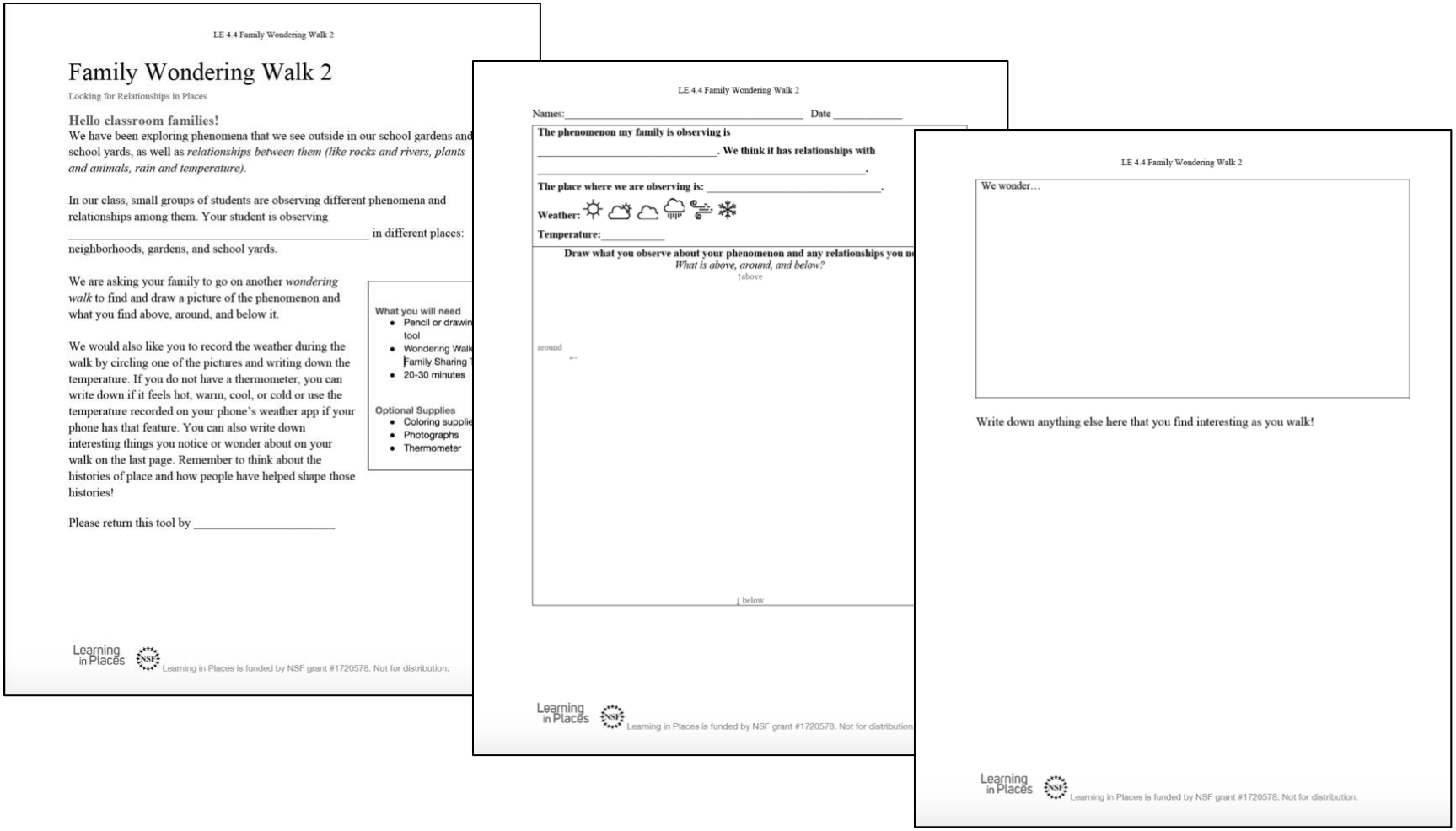
While LE 1.3 FAMILY PLACES facilitated spatial reasoning at the macro-scale of geographical areas, LE 4.4 WONDERING WALK 2 facilitated reasoning at a micro-scale focusing on psychological distance to the observed phenomena (Medin & Bang, 2014b). Research in embodied cognition demonstrates that perceived closeness or distance to focal objects or persons manifests in a range of reasoning and decision-making patterns based in perspective taking (i.e. first person or third person) (Libby et al., 2009; Medin & Bang, 2014b; Trope & Liberman, 2003). Medin and Bang (2014b) write that, “A third-person perspective is more abstract and focuses more on the why of action than the how. Furthermore, different pictorial representations affect perspective taking closeness facilitates adopting a first-person perspective” (p. 13,623).

Being psychologically close to or separate from focal objects of study implicate particular nature-culture relations and therefore possible forms of learning and knowing. Typically, in science education, the goal has been to psychologically distance oneself from the object of study in an effort for objectivity, which has resulted in a distancing of self and humans from ecosystems phenomena in the study of complex systems (i.e., conceptions of humans a part from nature, or nature-culture divides) (Bang & Marin, 2015; Medin & Bang, 2014a,b). This may negatively impact socio-ecological sensemaking and decision-making that requires ethical considerations of humans and human social-systems within more-

than-human other ecological systems (Berkes, 2017). It is for this reason that the tool both directs families to find and observe a focal phenomenon ("draw your phenomenon") in their backyard and neighborhood and represent what is above, around, and below it, from the perspective of the phenomenon. In other words, this tool prompts families to engage in embodied observation (look above, around, and below) as well as engage in representational reasoning through drawing in ways that facilitate reciprocal nature-culture relations and complex systems sensemaking.

There were two versions of this tool. Version 1 of the tool was implemented in co-design summits with families, educators, and community organization representatives as well as classrooms as part of their investigations. One kindergarten classroom in one school sent these home and received two consented tools back from families. Thus, revisions were made based on classroom implementation rather than evaluation of tool use in family practice. Revisions included minor changes to page layout (horizontal to vertical layout, more writing space) and the inclusion of a prompt to consider relationships.

Figure 4-4 Learning Engagement 4.4 Wondering Walk 2 Family Tool (version 2)



Note. Introduction (above left) frames the goals of the activity and essential materials. Tool Page 1 (above middle) asks families to find their focal phenomenon and to think about and draw observed relationships, attending to spatial orientations. Tool Page 2 (above right) asks families share wonderings and anything else interesting from their walks.

4.5.4. *Summary of Design Analysis*

Through this analysis, I illustrated how we designed a series of activities and mediational tools aimed at reconfiguring home-school relationships supportive of expansive science learning. We aimed to do this by beginning and centering familial stories and everyday practices as the grounds upon which to build and extend consequential scientific practice and culturally thriving disciplinary identity development. Additionally, we sought to cultivate epistemic practices that re-make relationships to lands, waters, and more-than-human others as meaningful to science and to familial and community wellbeing. In the next section, I analyze what families shared in response to the tools in connection to our core design propositions.

4.6. ANALYSIS 2: CONTENT ANALYSIS METHODOLOGY

In this content analysis of family responses to implemented family knowledge and practice sharing tools I take up the question: *what kinds of epistemic practices and knowledges, specifically in relation to our core design propositions, were elicited from families using these tools?* To answer these questions, I conducted a content analysis on FKPS tools from Learning Engagements 1, 2, and 4 (n = 58), organized around family discussions (n = 29) and family walks (n = 29). I conducted two rounds of coding and analysis, eliciting feedback and sensemaking at regular intervals. This was in addition to the iterative cycles of co-design, implementation, evaluation, and re-design that each tool underwent as part of the design process (see **Appendix 4A**). The first round of analysis was conducted with a subset of data (n = 10) for the purpose of helping teachers see the range of knowledges and practices shared by families in the tools as well as generate data-informed design decisions during co-design of the tools. I briefly describe round one of analysis in relation to the broader code development and content analysis procedures but do not delve into preliminary findings from this phase. Future papers will explore how teachers made sense of family knowledges and practices in collective sensemaking during co-design and in implementation of the storyline. The second round of analysis was conducted with the full data set in relation to the research questions described above.

4.6.1. *Coding Scheme & Procedure*

Coding scheme development occurred iteratively throughout analysis and collective sensemaking with the research team. The initial coding scheme was developed during round 1 of analysis using our framework for socio-ecological complex systems learning described earlier including the dimensions (a) species, kinds, and behaviors; (b) relationships; (c) places, lands, and waters; (d) thinking across scales; and (e) human presence and decision-making. Data for this first analysis included ten LE 2.4 WONDERING WALK 1 (v2) family tools completed in January 2019 in a second-grade classroom in Creekside Elementary. During this first round of analysis, I wrote design field notes for each of the major categories, attending to the content of families' noticings and wonderings and their constructions of place. I was particularly attentive to how place prompted their attention to particular phenomena. I then created a table that compiled all noticings across the five dimensions. Additionally, I wrote field notes about families' wondering questions. This table was presented at a research team meeting for collective sensemaking and refinement prior to sharing at the winter 2019 co-design summit.

From this initial analysis of noticings and wonderings as well as in collective sensemaking with the research team and co-designers, I created a codebook with subcodes for each of the five socio-ecological dimensions. This codebook was iteratively refined with the research team over two meetings prior to coding the full data set. Two headcodes were added: Next Generation Science Standards practices and phenology, with subcodes for each. Emergent codes were added to the codebook during coding and in collective sensemaking with the research team about emergent findings (see **Appendix 4I** for full codebook). For this paper, I focus on the five socio-ecological dimensions and describe each dimension of codes in relation to code analysis later in this paper. Future papers will explore the Next Generation Science Standards and phenology concepts emerging from families using these tools.

Coding Procedure. I coded all 58 family knowledge and practice sharing tools using the coding scheme described above and in **Appendix 4I** using Dedoose qualitative software. In order to maximize Dedoose capabilities and enable multiple analyses on the FKPS tools, each tool was fisrt photocopied and exported to an image (jpg) to be analyzed for representational depictions of phenomena (i.e., spatial

perspectives, detail of drawings, etc.; and secondly, all text fields in the tool were re-written into a word document. This enabled all text coding features in Dedoose (e.g., text search) and allowed for me to export coded text excerpts into an excel file for later data sensemaking and manipulation. During coding, each image and written response to a text prompt on the tool was coded using all seven head codes and related sub codes, and was coded with the particular tool prompt. For example, in this analysis, I pulled all text prompts for LE 1.3 FAMILY PLACES: "What does your family do in this place" in order to characterize the kinds of place-based familial and cultural practices elicited by the tool. I kept a running memo of themes that were emerging during the coding process. This was used to help cluster codes during analysis.

Analytic Procedures and Descriptive Findings. In this section, I describe my analytic procedures, including code clustering within each socio-ecological dimension and code distributions across all FKPS tools in order to provide a descriptive analysis of how families are using these tools. These interpretations will be further discussed in the findings section.

After coding each tool using the scheme described, I exported code presence into an excel sheet. Analysis was conducted using code presence/absence for each FKPS tool to account for variation in length of tools as well as variation in written or drawn responses. A present/not present analysis is a conservative measure of familial knowledge and practices as it does not account for multiplicity or depth of responses. For example, a family who identified four species of mammals received only one code presence for "mammal" (head code: species, kinds, and behavior). This analysis does, however, enable a comparative analysis across tools.

Next, I organized the codes into broader categories within each socio-ecological dimension to highlight themes and patterns emerging from the data at the tool level, activity level (indoor discussion/outdoor walk), and across the data set. This analytic process was iterative, informed by the theoretical and conceptual framework outlined previously, and grounded in the data (Merriam & Tisdell, 2016). To make sense of patterns, I generated data visuals (i.e., charts) using the exported code presence analysis for each dimension, cross-referenced these charts with excerpts/drawings from the tools, and

discussed preliminary claims with the research team for collective sensemaking and refinement. In the following sections, I describe the code scheme and analytic process of creating code categories for each five dimensions as well as descriptive analysis of code presence. As a reminder, these five dimensions are: (a) species, kinds, and behaviors; (b) relationships; (c) places, lands, and waters; (d) thinking across scales; and (e) human decision-making.

4.6.2. *Content Descriptive Findings*

Dimension 1: Species, Kinds, & Behaviors Codes and Code Categories. The FKPS tools were designed to scaffold attention to components with particular socio-ecological systems. LE 1.3 FAMILY PLACES was meant to facilitate recall of who/what share the places that families consider important - that is a mental model of the social and ecological system. The wondering walks (LE 2.4 and 4.4) were designed to scaffold attention to systems components through mobile and discursive patterns of observation. Thus a coding scheme of possible species and kinds was created and several additional types of species were added through grounded coding to capture the range of attentional patterns in families' responses. Additionally, reasoning about the behaviors and characteristics - also thought of as structures and functions - of more-than-human others has been shown to be a necessary practice of complex systems reasoning that shifts beyond taxonomic identification (Hmelo-Silver & Pfeffer, 2004). Codes were adapted from previous complex systems studies on children's place-based sensemaking (Montaño Nolan, 2016) with emergent codes added during the coding phase. **Table 4-2** shows all codes within this dimension. Codes in grey represent emergent codes.

Table 4-2 Coding scheme for species, kinds, & behaviors

Species	More-than-Human Kinds	More-than-Human Behaviors
Amphibian	Cloud	Adaptation/Evolution
Animal - General	Rock	Animal/Kind Specific
Bird	Soil/Dirt	Eating/Drinking
Fish	Sun	Life Cycle/Rearing/Growth
Fungus/Lichen	Weather	Visual Characteristics
Human	Water	
Insect/Arachnid/Bug, etc.		
Mammal (non-human)		
Pet (co-coded with mammal)		
Plant		
Prehistoric Animal		
Reptile		
Sea Invertebrate		

In this analysis, I was particularly interested in manifestations of nature-culture relations evidenced by whether and how families conceptualized humans as part of (i.e., relational) or separate from (i.e., divided) places, lands, and waters that were discussed and walked. In other words, did families notice and wonder about human presence during these science activities, and how did our tools facilitate or inhibit such conceptions? Prior research has suggested that non-Indigenous families often do not consider humans in their mental models of the natural world (Atran et al., 2005; Medin et al., 2007; Ross et al., 2007). It would be possible, then, that many families in our study would not include humans, or evidence of humans (i.e., cars, sidewalks, homes, etc. in their representations of their considerations of places, lands, waters or in their nature-walks. Thus, the thirteen *species* codes were organized into broader code categories that disaggregated "human" from "more-than-human" species. The code category "Human" includes both the "human" subcode and the *places, lands and waters* "building/built" subcode in order to account for both physical presence of humans and evidence of humans.

Table 4-3 shows the number and proportion of tools containing a present code for each code category: more-than-human species, humans/evidence of humans, more-than-human kinds, and behaviors. In the finding section, I disaggregate these numbers by activity structure (discussion/walk) as well as by sub codes.

Table 4-3 Number and proportion of tools coded with species, kinds, and behaviors categories across all FKPS tools

	More-than-Human **Species**	**Human**/ Evidence of Human	More-than-Human **Kind**	More-than-Human **Behavior/ Characteristic**
Number of Tools	51	43	17	25
Proportion of Tools	87.93%	74.14%	29.31%	43.10%

Family knowledge and sharing practice tools LEs 1.3, 2.4, and 4.5 (n = 58)

Across FKPS tools, we see that the majority of families included a more-than-human species in their responses to the prompts, while less than a third included a more-than-human kind. Further, less than half of the tools include a behavior or characteristics of the more-than-human other (species or kind). As I discuss in more detail in the findings section, our tool prompts and activity structures matter for facilitating or inhibiting complex systems reasoning and there are important differences between the discursive indoor practices and outdoor mobile practices.

Dimension 2: Relationships. To support complex systems learning about relationships within socio-ecological systems we took two approaches: first scaffolding towards recognizing base pair relationships that can be observed in the natural world (e.g., eagle - tree, salmon - tree, etc.), then studying the type of relationship (e.g., ammensalism, commensalism, etc.) across scales. Additionally, we aimed to support web-like, relational reasoning including and beyond simple causal chains as well as seen and unseen relationships over time (Learning in Places, 2020d). This was particularly focused later in the storyline (during data collection and sensemaking). This type of nature-culture relational reasoning is necessary to complex systems sensemaking and decision-making (Medin et al., 2014). From these family knowledge and practice sharing tools, I wanted to know the kinds of base relationships discussed and

observed in relation to place. For this analysis, I only include written base relationships. Future analysis will study the relationships depicted in artistic representations. Additionally, future analysis will characterize the type of relationships identified, described, or wondered about, particularly for three or more species/kinds relations within the system. **Table 4-4** shows the coding scheme.

Table 4-4 Coding scheme for base relationships

Base Pair Relationships	
Animal - Animal	Kind - Kind
Animal - Kind	Kind - Place
Animal - Place	Human - Animal
Animal - Plant	Human - Human
Plant - Plant	Human - Kind
Plant - Place	Human - Plant
Plant - Kind	Human-Place

These 14 base relationships were clustered into two categories: more-than-human only base pairs (i.e., those that do not include a human as a pair), and human plus other base pairs. Here again, I was interested in constructions of nature-culture relations where humans are conceptualized as either in-relation-with or absent-from the natural world, as well as how they attended to more-than-human relationships in the natural world. I calculated how many tools contain any type of base pairs or no base pairs. Tools without a base pair were excluded from further analysis of relationships. In the finding section, I breakdown the number and proportion of base pairs across activity structure.

Table 4-5 displays the number and proportion of tools within these categories across all FKPS tools. Approximately 80% of families included at least one base pair relationship in their written responses, suggesting that the majority of families are engaging in some form of relational reasoning as opposed to taxonomic (i.e., solely naming singular species). Nearly two thirds of families included a base relationship where humans were part of the pair. Nearly one third of families included base pairs with no humans. This could indicate that families are conceptualizing humans as part of socio-ecological systems, rather than absent from systems, and are reasoning about their role and relationships within the system.

Table 4-5 Number and proportion of tools coded with base relationships across all FKPS tools

	Any Base Pairs	**More-than-Human Only** Base Pairs	**Human + Other** Base Pairs
Number of Tools	43	16	33
Proportion of Tools	81.13%	30.19%	62.26%

Family knowledge and sharing practice tools LEs 1.3, 2.4, and 4.5 (n = 58)

Dimension 3: Places, Lands, & Waters Codes and Code Categories. Reflecting our attunement to place as a socio-historical construct (Gruenewald, 2003; Headrick Taylor, 2017) and recognizing that different ecosystems contain diverse semiotic resources for learning about complex systems (Pugh, 2019); I created a coding scheme representing kinds of places and ecosystems present in FKPS tools (**Table 4-6,** primary codes). These were meant to capture both human-centered environments (indoors and outdoors) as well as natural places.

Making sense of and organizing these codes occurred in two phases. First, I asked how families conceptualize their relationships to important places (i.e., what kinds of places are important and why). To answer this question, I created a secondary coding scheme that was applied to all primary places, lands, and waters excerpts in LE 1.3 FAMILY PLACES only. These codes were generated from memos and sensemaking during the coding and preliminary analysis phase. I identified four types of relationships with the places identified: vacation places, former homelands, current homelands, built environments, and natural places. Next, I conducted a present/not present analysis of LE 1.3 tools with these secondary codes. This clustering proved helpful in interpreting nature-culture relations vis a vis families' conceptions of places, their importance, what they do in these places, and who they share these places with (I describe this in more depth in the findings section). However, this clustering was inadequate to describe the places, lands, and waters families walked when completing LE 2.4 and LE 4.4 Wondering Walks. Collective sensemaking around this issue with the research team generated a next analytic question and third round of coding.

We wondered about the scales of spatiality that were present in the FKPS tools that might reflect how families are reasoning about their relationships with places, lands, and waters. In other words, how might reasoning about places proximally close versus distant affect sensemaking about local and global phenomena? Reviewing families responses in LE 1.3 FAMILY PLACES reflected both politicized dimensions of place-making in regards to nation-state contexts as well as localized and global patterns. Thus, a tertiary coding scheme was created to identify whether families were identifying local or global places. These codes were applied to all excerpts containing places, lands, and water code across all FKPS tools.

Table 4-6 Coding scheme for places, lands, and waters

Primary Codes		**Secondary Codes**	**Tertiary Codes**
Kinds of Places	**Ecosystems**	**Relationships**	**Scale of Place**
Waters	Beach	Vacation Place	Local
Backyard/ Neighborhood	Forest/ Woods	Former Homeland	Global
Building/Built Place	Island	Current Homeland	
Other Nation	Mountain	Natural Place	
Other State in the U.S.	Wetlands		
	Park/ Nature Preserve		
	Desert		
	Prairie		

A final clustering of codes produced five categories of spatial scales: (a) immediate backyards and neighborhoods (code: local + backyard/neighborhood); (b) local lands and waters (codes: local + ecosystems, waters); (c) U.S. nation-state places (code: local + other state in U.S.); (d) global nation-state places (code: global + other nation); and (e) global lands and waters (global + ecosystem, waters). Code presence/absence was then conducted on this data. **Table 4-7** shows the number and proportion of tools containing scales of place codes.

Table 4-7 Number and proportion of tools that were coded as places, lands, and waters across all FKPS tools

	Immediate Backyards and Neighborhoods	Local Lands & Waters	U.S. Nation States	Global Nations	Global Lands & Waters	No Identifiable Place
Number of Tools	22	23	3	8	9	5
Proportion of Tools	37.93%	39.66%	5.17%	13.79%	15.52%	8.62%

Family knowledge and sharing practice tools LEs 1.3, 2.4, and 4.5 (n = 58)

These broader categories were not mutually exclusive, meaning that a family could identify both a local land/water and a global land/water in their response to a tools' prompt. For example, one family reasoned about a local island (within a day's journey from the city) in relation to rising oceans and climate change more globally in LE 1.3 FAMILY PLACES. I found significant differences between the family discussion and family walk tools that I discuss in the findings section.

***Dimension 4: Thinking Across Scales Codes and Code Categories*.** I attended to two aspects of thinking across scales in the FKPS tools: temporal and perspectival. First, I examined the temporal dimensions as organized by our histories of place framework and implemented in LE 1.3 FAMILY PLACES (page 4). I wanted to know whether and how families were using these socio-ecological dimensions of time and if there were differences between what they said they know versus what they wanted to know about each time scale. As such, I coded their responses first to each time scale and then to whether it was a known or question response. **Table 4-8** contains the code scheme for temporal scales. These were not clustered into any code categories.

Table 4-8 Coding scheme for temporal scales

Prompt Codes	Histories of Place Codes
Know about	Geologic Time
Have question about	Plant & Animal Time
	Indigenous Peoples' Time
	Recent/Current Time
	Nation-State Time
	Ethical Responsibilities/ Possibilities Time

Table 4-9 contains the number and proportion of tools coded with temporal scales (family discussion only, n = 29). More than half of families responded to the temporal dimensions of LE 1.3 FAMILY PLACES, with most families knowing or having questions about plant and animal time, followed by Indigenous peoples' time and geologic time. In general, responses to plant and animal time included wonderings about who lives in these places, evolutionary adaptations that have helped plants/animals live in these places, and identifying particular species. Responses to Indigenous peoples' time were often naming specific tribes, sharing knowledge about Indigenous practices (e.g., medicine, foods, culture, etc., and indications that families want to know more about Indigenous peoples. Families generally wrote about geologic time in terms of continent formation (e.g., plate tectonics, mountain formation) and glacial formation/recession, including present-day changes to lands and waters. Responses to recent time (v1, n = 7) included knowledge and questions about ecological phenomena (e.g., "glaciers are melting", "how can we detect earthquakes"), socio-political phenomena (e.g., "Trump is now president, uh-oh," "skyscrapers have been built"), and socio-ecological phenomena (e.g., "more plants and trees planted near building," "protect the environment"). Responses to nation-state time prompts (v2, n = 5) focused entirely on socio-political relationships (e.g., "with more people coming to [this city], tourism is increasing," "there was a revolution to safe Cuba, for equality"). Finally, families responded to ethical responsibilities with individual and collective choices for resource conservation and concern for climate changes. The range and depth of socio-ecological deliberations and potential decisions found in

these short prompts suggest that families' discussions were rich with opportunities for expansive learning. I explore this finding and potential implications in more detail in the finding section.

Table 4-9 Number and proportion of tools coded with a temporal scale in family discussion

Spatial Representation Codes	Drawing Perspective Codes	Drawing Distance Codes
Drawing	View from above	Below Ground
Photograph	View straight on	Close up
Words (no picture)	View from below	Mid-view
Blank		Distance

After an analysis focused on temporal dimensions of socio-ecological systems in family discussions, I analyzed for perspectival reasoning in family drawings across both discussion and walks. While places, lands, and waters analysis focused on spatial scales emergent from families' discussions of- and from walking in- places, the codes in this particular dimension focus on the psychological distance and perspective taking in family drawings of places. The perspectival scales in this coding scheme are adapted from previous studies with children's illustrated children's books (Medin & Bang, 2014b). I first coded for whether the families drew, used a photograph of words (no drawing), or left the drawing space blank. Then all drawings were coded with perspective codes. **Table 4-10** contains codes for perspectival scales.

Table 4-10 *Coding scheme for perspectival scales*

	Drawing Perspective			**Drawing Distance**			
	View from above	View from below	View from straight on	Below ground	Close up	Mid-view	Panorama/ Distance
Number of Tools	13	2	39	2	8	37	3
Proportion of Tools	27.66%	4.26%	82.98%	4.26%	17.02%	78.72%	6.38%

Family knowledge and sharing practice tools LEs 1.3, 2.4, and 4.5 containing a drawing (n = 47)

I found 47 family tools included a drawing (81.03%), compared to three with a photograph, two with only words, and six tools with blank drawing spaces. **Table 4-11** contains the number and proportion of tools with drawing perspectives and does not include photographs or written responses.

Table 4-11 Number and proportion of tools coded with perspectival drawing scales

	Geologic Time	Plant & Animal Time	Indigenous Peoples' Time	Recent Time/ Nation-State Time	Ethical Responsibilities	Blank Page
Number of Tools	19	21	20	12	14	8
Proportion of Tools	65.52%	72.41%	68.97%	41.38%	48.28%	27.59%

Family discussions (n = 29)

Figure 4-5 shows examples of student drawings featuring different perspectives and distances. The majority of drawings featured a view from straight on and mid-view, meaning that the drawing encompasses the full field of view from eye-level (**Figure 4-5-A**). Slightly less than a third of tools featured a view from above, as if the person were looking down on something. These included both panorama/distance views (**Figure 4-5-B**) and close-up views (**Figure 4-5-C**). Only two drawings featured a view from below, as if the person drawing were looking at something above them. These findings suggest that the majority of families adopted a more abstract or distanced view of phenomena when drawing (Medin & Bang, 2014a). I found the most varied views (above/below and close-up) typically occurred in LE 4.5, which is unsurprising given the prompts to include what is above, around, and below were designed specifically to facilitate different perspectives and psychological closeness.

Figure 4-5 *Examples of perspectival scales from student drawing*

Notes
Figure 4-5-A (above left) shows a 2nd grade Parkview student feeding ducks at a local lake from LE 2.4, WONDERING WALK 1. The image exemplifies a perspectival view from straight on and mid-view.
Figure 4-5-B (above middle) shows a 2nd grade Creekside student's drawing of their families' important place in LE 1.3 FAMILY PLACES. This image exemplifies a perspectival view from above and at distance.
Figure 4-5-C (above right) shows a 2nd grade Creekside student's drawing of a slug from LE 4.4 WONDERING WALK 2. The image exemplifies a close up view from above with careful detail to the slug's visual characteristics.

Dimension 5: Human Decision-Making Codes and Code Categories. I created a coding scheme to understand the range of familial practices, particularly those that visiblize nature culture relations by coding for outdoor and indoor family practices where nature was foregrounded, backgrounded, or absent. I conceptualized human decisions in this analysis as the everyday practices and activities of families and communities. These codes were adapted from cross-cultural studies of human cognition in the realm of folk-biology (e.g., Bang et al., 2012; Medin & Bang, 2014a) where such epistemic practices afford differences in biological reasoning about socio-ecological systems. In particular, Bang and colleagues (2012) suggest that epistemic practices foregrounding nature (e.g., hiking, harvesting, feeding ducks at a pond) would afford a psychological closeness with nature whereby humans are considered part of nature - that is reciprocal nature-culture relations. The purpose of such activities is to be outside and engage with more-than-human others, lands, and waters in some way. Epistemic practices backgrounding nature (e.g., playing on a playground, hanging out with friends, etc. psychologically distance humans from nature, or nature-culture divides. While such activities might be outdoors, the object of the activity is not to engage with more-than-human others, lands, or waters. Similarly, epistemic practices where nature is absent (i.e.,

indoors) might also contribute to psychological distancing where nature-culture relations are physically as well as conceptually separated. I also added an emergent code, helping/hurting relations whereby families narrate an ethical dimension of their relationships with the natural world (e.g., stop polluting, save wildlife). Further, I added an "unknown" code to track when families identified a practice but it was unclear from their response whether it was nature foregrounding, backgrounding, absent, or helping/hurting. **Table 4-12** contains the coding scheme for nature-culture epistemic practices, emergent codes in grey. **Table 4-13** shows the number and proportion of tools with an identified epistemic practice (n = 29).

Table 4-12 Coding scheme for human decision-making

Nature-Culture Practice Identified
Nature Foregrounded
Nature Backgrounded
Nature Absent
Unknown
Helping/Hurting Relations
No Nature-Culture Practice Identified

In analyzing the FKPS tools, the family walks did not explicitly ask families to identify or describe a familial practice, as such I found only four family walks that indicated a family practice (feeding the ducks and regularly walking local trails). These four families indicated that the wondering walks were building on routine practices of engaging in their local neighborhood ecosystems. However, 26 other family walks did not elicit such information and were excluded from further analysis. Additionally, three families did not identify a family practice in the LE 1.3 FAMILY PLACES tool. These were also excluded from analysis of nature-culture relations.

Table 4-13 Number and proportion of tools with a human decision-making code

	Nature Foregrounded	Nature Backgrounded	Nature Absent	Unknown	Helping/ Hurting
Number of Tools	15	6	16	8	7
Proportion of Tools	51.72%	20.69%	55.17%	27.59%	24.14%

Family knowledge and sharing practice tools LEs 1.3, 2.4, and 4.5 containing a human decision-making code (n = 29)

I found nearly equivalent proportions of tools containing foregrounding and nature-absent familial practices. In nature-absent practices, families typically identified an indoor activity. This supports previous findings that human-centered environments do not generally afford epistemic practices where the natural world is a salient semiotic resource for meaning-making (Bang & Marin, 2015). This further supports our desire to design learning environments that take place outdoors, both in school-based practice and in home-school relations. Asking families to go on routinized walks as connected to their children's expansive science learning may offer a way to re-configure home-school practices that are also consequential to place-making with lands, waters, and more-than-human others.

4.6.3. *Summary of Analytic Procedures and Preliminary Findings*

It was the purpose of this analysis to answer my question *what kinds of epistemic practices and knowledges, specifically in relation to our core design propositions, were elicited from families using these tools?* To do this, I created a coding scheme that investigates how families' knowledge and practices are elicited in these tools. These included five head codes and a range of subcodes that visiblize core dimensions of socio-ecological systems sensemaking in relation to nature-culture epistemic practices and field-based science practices. After coding all 58-family knowledge and practice tools, I conducted a code present/absent across all tools and organized codes into meaningful clusters based on my conceptual framework and sensemaking with the data (i.e., data visuals and collective sensemaking with the research team).

I found that these tools visiblized a range of knowledge and curiosity about the socio-ecological systems of places that are important to families. These were arranged across different dimensions of socio-ecological sensemaking that could contribute to field-based investigations over the course of a year. Additionally, an analysis of these tools highlighted a range of nature-culture relations embedded in families' everyday activities, and through engagement in scientific disciplinary activity. Further, an analysis of these tools demonstrated key affordances and constraints of our designs that work towards the kinds of expansive and consequential science education discussed at the beginning of this paper. In the next section I highlight two key findings emerging from this analysis that illustrate these affordances and constraints of our designs.

4.7. CONTENT ANALYSIS FINDINGS

4.7.1. *Finding: Thinking Across Spatial and Temporal Scales in Family Discussions*

The analysis of family tools indicate that families engaged in thinking across temporal and spatial scales, a key aspect of complex systems thinking, in their responses to LE 1.3 FAMILY PLACES tool. Families identified a range of places, lands, and waters that were important to their family and familial wellbeing that spanned multiple geographic and politicized scales. A Chi Square test of independence demonstrates that family discussions and family walks yielded significantly different responses to places, lands, and waters, χ^2 (5, 58) = 27.755, $p < 0.001$. Family discussions of important places, and the prompts used to facilitate reasoning across spatial and temporal scales supported a diversity in conceptions of place. Whereas, all family walks were conducted in backyards/neighborhoods and local lands and waters. This was a key learning for our project. The stories that families shared about migration and mobility across multiple generations and geographic scales asked us to think about how we were designing to support such sophisticated temporal and spatial reasoning across the storyline. The remainder of our learning engagements across the storyline had not intentionally asked students, classrooms, or families to engage in such scaled spatial reasoning beyond LE 1.3 FAMILY PLACES. This has been a new design edge of our work as we consider how our designs for expansive and consequential science learning are now also responsive to places at global scales, not just local.

Asking families to reason about these places across multiple temporal scales (i.e., geologic time, plant and animal time, Indigenous peoples' time, nation-state time, and ethical responsibilities and possibilities time) facilitated perspective taking from more-than-human others and ethical relations with these places. To illustrate this finding, I describe each of these spatial scales in relation to the identified epistemic practices and conceptualization of familial relations found in these tools to suggest the range of possible nature-culture relations and complex systems learning in families' reasoning.

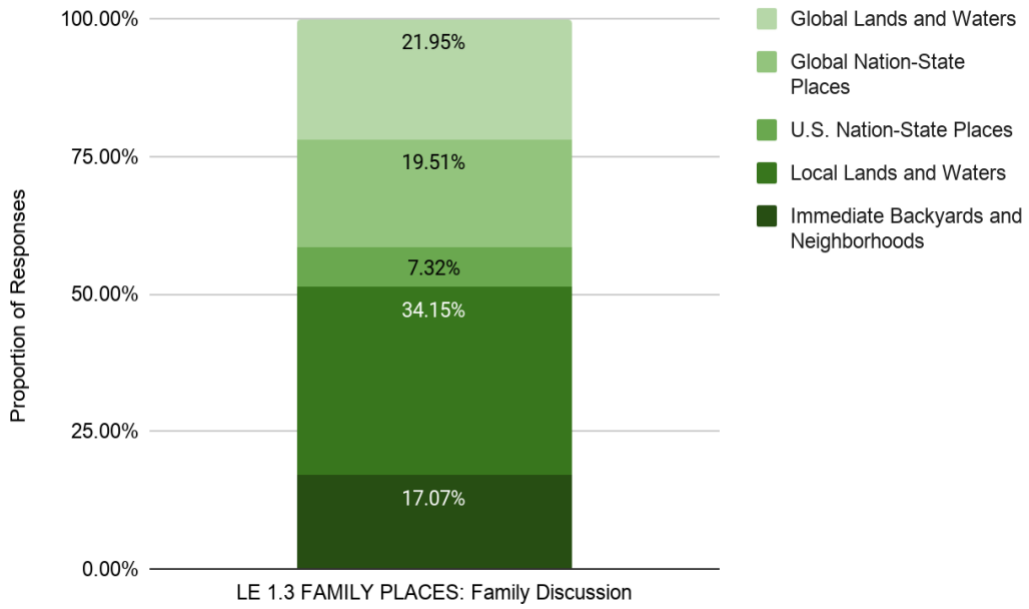
Epistemic Practices Across Conceptions of Places, Lands & Waters. **Figure 4-6** depicts the proportion of family responses to places, lands, and waters, illustrating the key spatial scales emerging in families' conceptualizations of important places. I highlight two key aspects of these findings. First, the variation in family responses across the data set demonstrates that singular definitions of- or relations to- "place" are insufficient to capture the heterogeneity of conceptions. As I illustrate in the following description of each scale, family conceptions of important places included geographic, temporal, and socio-political dimensions that shape what and how we learn about social and ecological systems. Secondly, the inclusion of transnational and global places in some families' responses expands beyond what place-based education has emphasized as (re)making local relations to lands, waters, and communities. Instead, these findings evidence that diasporic families across multiple generations are trying to (re)make and sustain relations to places at multiple geographic and temporal scales, and grappling with socio-political dynamics. As I argue more in the discussion of affordances and constraints, activity-tools that support families, educators, and young learners attend to these multiple and powered layers of space-time is necessary for both consequential science learning and intergenerational familial thriving. To explicate this, I discuss familial responses to each spatial scale in more depth.

Approximately 17% of families named backyards and neighborhoods as their important place. Generally, these families referred to built-environments such as homes, local restaurants, community centers, and places of worship and nature-absent familial practices that centered desires to be with family, friends, and God. Additionally, families said they felt safe and content, reflecting a sense of belonging in these places. This suggests that families are identifying the places and social networks that support their

familial wellbeing and would be important connections for expansive science learning that facilitated the wellbeing and thrivance of such places.

Families also identified local lands and waters as important (34.15% of families). These local lands and waters included regional islands, mountain ranges, beaches, and forest ecosystems (within a day's drive), a stream and wetlands within walking distance of Creekside Elementary and Parkview Dual Language School (respectively), and greenspaces in neighborhood parks. I found two predominant nature-culture constructions of these places: places that facilitated human-human relationships and places that facilitated human-human-nature relationships.

Figure 4-6 *Proportion of spatial scale responses in LE 1.3 Family Places tool*



Many families identified local lands and waters where they could gather and reconnect with family and friends (picnics, parties, playgrounds) (41.6% of families with local lands/waters code). The purpose of these places was to facilitate human-human relations with important people in families' lives. For example, one family wrote that they go to a local beach to "share events, birthdays, and time with family and friends." The object of these routine family practices suggests nature-culture divides as majority of these practices were nature backgrounded; however, when prompted to consider what they

wanted to learn about these places and reason across time scales that centered more-than-humans (i.e., geologic time, plant and animal time, etc. Families wrote that they wanted to learn more about ecological relations. For example, the family who went to the beach for family gatherings said they wanted to learn more about "sea creatures, crabs, and birds" and felt "history connections and feel that people and families hundreds of years ago felt the same." This suggests that although the primary objective of families' visiting local lands and waters may be to engage in nature-backgrounded activities, families want to know more about the social and ecological dimensions of these places. That is, new epistemic practices could be facilitated in places that already matter to families as a way to encourage reciprocal nature-culture relations.

For other families, the object of activity in visiting these places was specifically to "get-away" from urban (i.e., human-dominated) spaces and "reconnect" with nature, such as going on hikes, camping, and learning about the natural world with their family (approximately 58% of families with a local land/water code). Families said they wanted to learn more about the wildlife and history of these places and felt happy to be there. For example, in response to the tool prompt *how do you feel when you are in this place* one family wrote "I feel excited and it's cool because I like the nature and to see the animals like the salmon" to describe their routine family walks through Arroyo Park. Others wrote about being together with their family and friends in nature as a source of rejuvenation.

This suggests a psychological closeness with the natural world where being in/with nature was desired and enacted through nature-foregrounded epistemic practices. Research in folk biology demonstrates that psychological closeness through engagement in routine epistemic practices in/with places can support complex systems sensemaking, including facilitating web-like causal reasoning patterns (e.g., eating relations) and ecological reasoning patterns (e.g., habitat relations) (Medin et al., 2014; Marin, 2013; Montaño Nolan, 2016; Pugh et al., 2019). I found that many of the families in this study already engage in such epistemic practices and may have robust knowledge about complex systems that can and should be engaged in rigorous and expansive science learning.

Families also identified places in terms of their U.S. and global nation-state relationships with these places (26.83% of families). For example, 19.51% of families named another nation as their important place and shared that maintaining connections with friends and family is a routine practice in which they engage (nature-absent). Some shared stories of migration and reasons for coming to the U.S. Another 7.32% of families named other U.S. cities as important places where they had lived and/or have family currently living. These families are conceptualizing their relationships with places, including the one in which they currently live and send their children to school, in terms of politicized and racialized geographies. Additionally, they said they want to learn more about these places from this politicized dimension. For example, in response to the prompt "*what are you curious about this place"* one family responded "How did Donald Trump take it over in the first place, because I have a feeling it's because of him that we had to leave our home." Another wrote in response to questions they have about nation-state time asked "Why did he [Fidel Castro] want to save Cuba?" In these examples, families are navigating powered and historicized nature-culture relations. Making science learning consequential may mean grappling with nation-state histories and conceptions of places that recognize "[n]ot only is our experience of places mediated by culture, education, and personal experience, but places themselves are products of culture" (Gruenewald, 2003, p. 626).

Finally, some families considered global lands and waters such as oceans, continents, glaciers, etc. (21.95% of families); however, families did not name global lands and waters as their important places, but reasoned about the impacts of climatic changes at the global level on their local places (nation-state, lands/waters, and backyards/neighborhoods). This included shifts such as glacial melt, drought affecting desert ecosystems, and pollution in oceans and rivers. I saw this most often in response to geologic and ethical responsibilities/possibilities time scales as families wondered about environmental changes over historic and future times, and human roles in such changes. Nearly ¼ of all families named a human helping/hurting relationship in terms of ethical responsibilities and possibilities. These were generally focused at the individual choice level (we should stop polluting); however, some families

named policies (e.g., water consumption laws) or state/national-protection of lands and waters that could help mitigate socio-ecological devastation.

Design Affordances and Constraints of LE 1.3 FAMILY PLACES Tool. Facilitating a discussion about an important place afforded the opportunity for families to consider places they have visited and previously lived, share stories from those places, and think about ecological relations across spatial and temporal scales. Families identified phenomena at global levels that are impacting local places and reasoned about human decisions that might mitigate natural and human-made disasters. Further, they considered sociological and politicized dimensions of places and human mobility across these places, which I explore in connection to place-based and land-based education in the conclusion of this paper. This sensemaking is a cornerstone of complex systems thinking, particularly socio-ecological complex systems. Facilitating such discussions as routine home-school practices may support both expansive science learning that matters to the places, lands, and waters students and families consider important to their wellbeing and imaginative possibilities for cultivating and sustaining healthy relations.

One constraint of the tool was that the majority of epistemic practices shared in family responses were human-centric. The prompts asked families to consider a place important to their family and tell stories from that perspective. Most of the nature-foregrounded practices identified were in terms of the needs and desires of humans to connect with or consume nature. This was also evident in constructions of helping/hurting relations where humans need to stop hurting the natural world by reducing pollution and consumption of natural resources. Humans were considered agentic, stewards of lands and waters, positioning human dominance in what can be done and what can be known about the natural world. This finding parallels cross-cultural research that has shown urban non-Natives often reason about the natural world in terms of human centrism and consider more negative human relations with the natural world (Medin & Bang, 2014a). Our discussion tool may have replicated and facilitated this kind of human-centric reasoning, even as it expanded opportunities for sophisticated complex systems thinking across spatial and temporal scales in ways that visiblize how families are navigating power, privilege, and culture in their place-based relations.

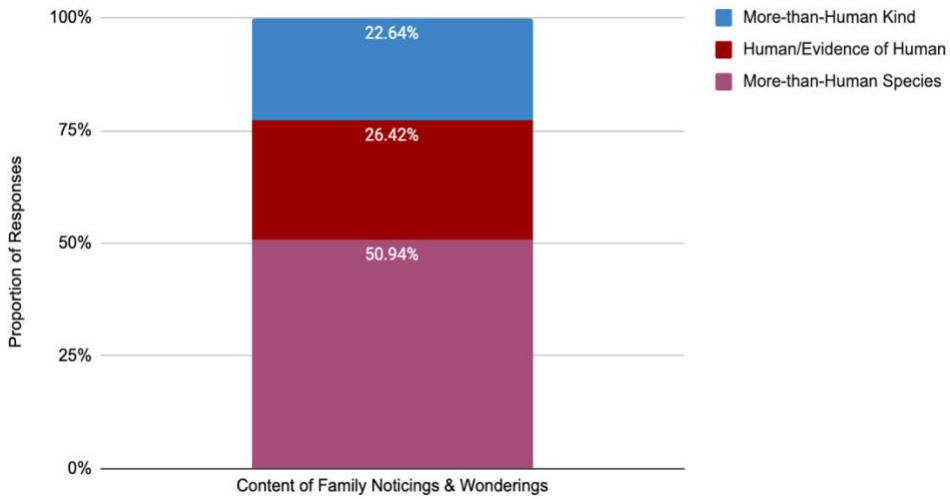
This finding builds on much research contending that careful attention to design politics is necessary for structuring epistemic possibilities in unfolding activity. Opening space to make speakable historicized and politicized dimensions of place-making across multiple scales of familial activity (local and global) may be consequential new ground for science learning in the early grades. However, beginning with or centering these human-relations in the absence of or reciprocal or deferent human relations may reinforce human dominant conceptions of places, lands, waters, and more-than-human others in ways that are antithetical to the kinds of transformative socio-ecological changemaking necessary for addressing 21st century challenges. In the next finding, I explore how mobile, discursive epistemic practices provide opportunities for sensemaking and place-making that may work to de-center humans and open space for observing and wondering about more-than-human others in neighborhood ecosystems.

4.7.2. *Finding 2: Observational Practices in Walking*

Families identified a range of species and kinds and asked investigative and explanatory questions about their behaviors and relationships during tool-mediated observation walks in their backyards, neighborhoods, and local lands and waters. I argue that these tool-mediated walks both expanded opportunities for families to (a) observe and wonder about species, kinds, behaviors, and relationships which are necessary to complex systems learning; and, (b) decenter human exceptionalism through attentional scaffolds to wonder about human and more-than-human relations in place. I illustrate this with a focused analysis on the types of species, kinds, and relationships that families attended to. I also argue that these tools focused explicitly on observing in local places, within walking distance for families, without scaffolds to consider global places, lands, and waters. To illustrate this, I first describe what they noticed in their local socio-ecological systems as they engaged in the epistemic practice of walking and reading the land. I then characterize the patterns of behaviors and relationships they noticed and wondered about. Finally, I close with a discussion of affordances and constraints of designed family walks.

Taxonomic Representations in Family Walks. In our conception, lands and waters are semiotic resources for place-based noticing of components within a system, and the purpose of the family wondering walks was to coordinate attention to those semiotics through field-based observation. I was interested in understanding what features of neighborhoods and local lands/waters were salient during family walks and conducted a taxonomic analysis of species and kinds families observed and represented in their drawings and written responses in FKPS wondering walk tools. **Figure 4-7** displays the proportion of species and kinds found in the content of families' observations and wondering questions elicited from place (n = 29). I analyzed both drawings and written responses. All drawings and writing were done by students, however I use the term "families' responses" to denote the content that was selectively included in the tool. Previous research has demonstrated that families engage in joint attentional patterns (linguistic, gestural, and corporeal arrangements) to coordinate sensemaking during the epistemic practice of walking and reading the land (e.g., Bang et al., 2014; Marin, 2013; Meixi, 2019; Pugh, 2019). Therefore, I presume that because this was a joint activity, families may have collectively decided what to include in drawings (or not) through multimodalities not represented in the drawing done by a single individual. All walks were conducted in backyards/neighborhoods and in local lands and waters.

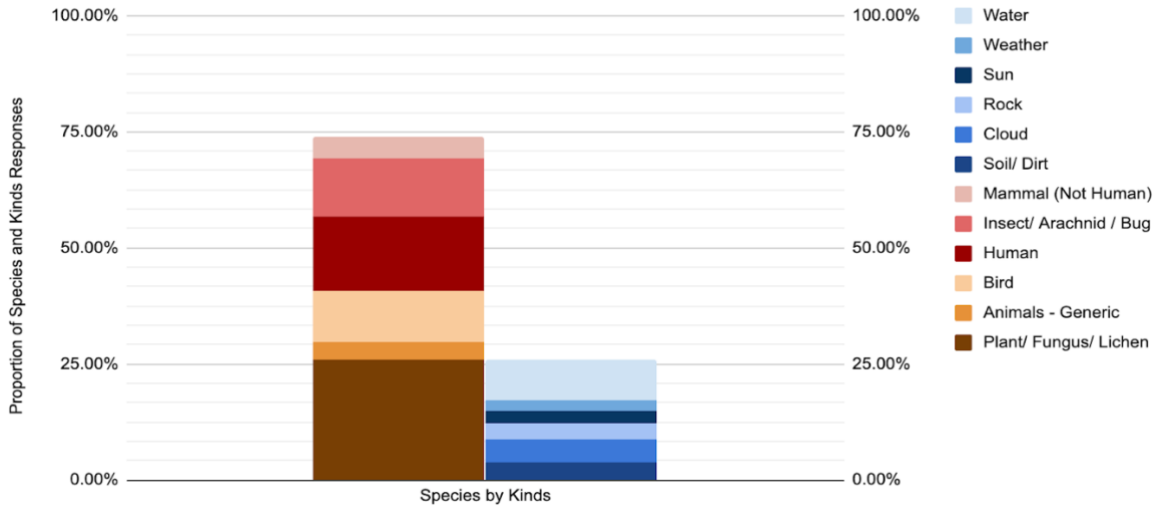
Figure 4-7 Proportion of species and kinds responses in LEs 2.4 and 4.4 FAMILY WALKS



More-than-human species made up roughly ½ of all observation noticings and wonderings found across the FKPS family wondering walk tools, followed by humans (26.42%) and more-than-human kinds (22.64%). Only two families did not include any drawings or written noticings/wonderings of a more-than-human species (both in the first wondering walk, LE 2.4). One of these families drew a construction site in their neighborhood with detailed drawings of the house, construction equipment, and the student and members of the family observing the activity. The other wrote they took a walk in their neighborhood and it is important to "learn things" with family, but did not include any responses to noticings or wonderings during their walk.

Figure 4-8 shows the proportion of each type of species and kinds found in the FKPS family walk tools. For this analysis, I did not include evidence of humans (e.g., cars, building, equipment, etc. but only drawings or written inclusion of a human being. There were no representations of amphibians, fish, pets, sea invertebrates, or prehistoric animals, which were present in families' discussion of more-than-humans others who share their important places. Families predominantly represented plants (25.93% of responses), birds (11.11%), humans (16.05%), and insects (12.35%) species in their observations. There were some representations of natural kinds, predominantly water (8.64% of responses) and clouds (4.95%).

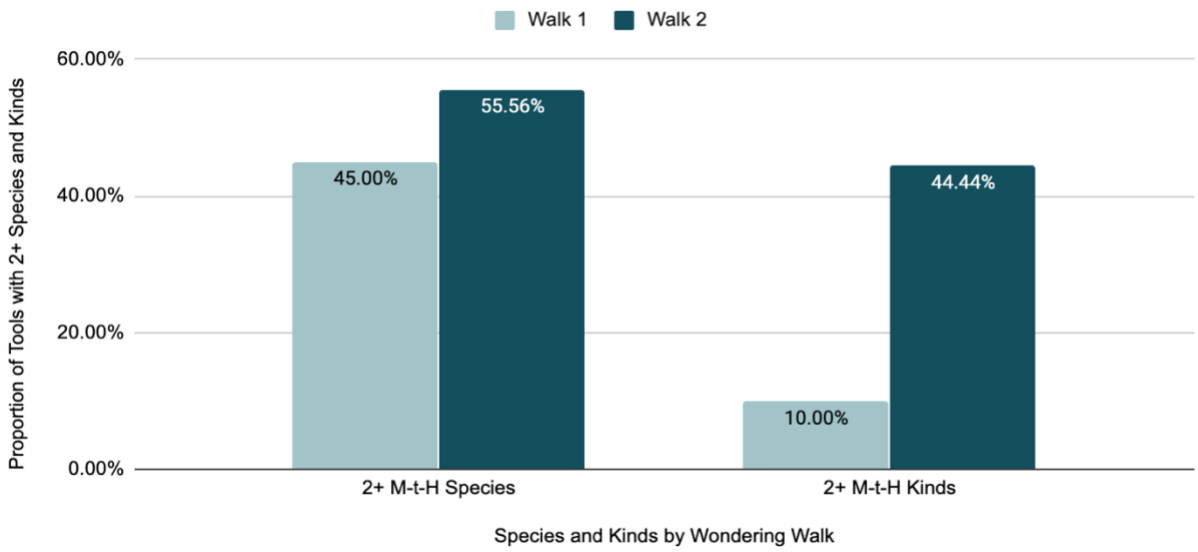
Figure 4-8 Proportion of type of species and kinds responses in LEs 2.4 and 4.4 FAMILY WALKS



Families also generally included more than two types of more-than-human species in their noticings (51.72% of families across all walks). The proportion of families including two or more species and kinds in their responses increased in the second wondering walk which explicitly facilitated noticing both a focal phenomenon in relation to what is above, around, and below it (**Figure 4-9**).

Figure 4-9 shows the increase of 2+ more-than-human species from walk 1 to walk 2. Representations of natural kinds quadrupled in the second wondering walk, suggesting that the tool facilitated families noticings below and above may have attuned them to the relationship of natural kinds (i.e., sun and clouds above, and rocks and soil below).

Figure 4-9 Proportion of tools with more-than-human species versus kinds compared across LE 2.4 WONDERING WALK 1 and LE 4.4 WONDERING WALK 2

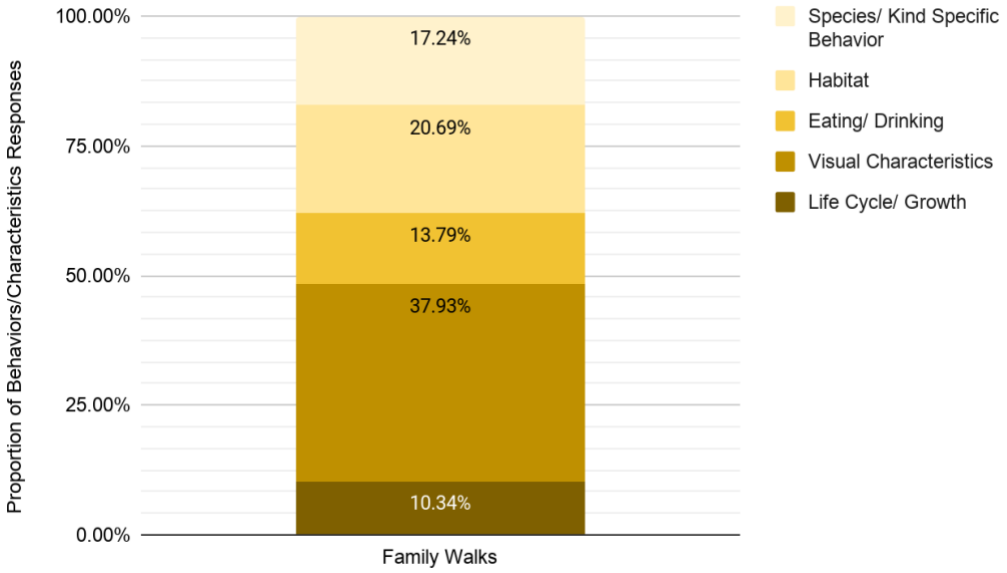


Complex Systems Thinking across Species and Kinds. In addition to noticing a diversity of species and kinds in local socio-ecological systems, families also observed and wondered about behaviors and relationships. Reasoning about relationships and functions of components within a system is a foundational practice of complex systems learning and decision-making (Hmelo-Silver & Pfeffer, 2004) and recognized as a disciplinary core idea in NGSS (Schwarz et al., 2017). However, it is also suggested

that many young children engage in taxonomic reasoning because ecological (i.e., place-based) or relational reasoning (i.e., between species/kinds) can be difficult (Carey, 1985; c.f., Bang, 2015; Medin et al., 2014, Marin et al., 2013; Montaño Nolan, 2016). I wondered whether and how families were reasoning about the behaviors and relationships of the species and kinds they observed on their wondering walks.

Behaviors and Characteristics of Species/Kinds. I conducted an analysis of the proportion of behaviors and characteristics and base relationships found in families' written noticings and wonderings (Figure 4-10). **Figure 4-10** shows the proportion of each type of behavior and characteristic of a more-than-human species/kinds that families wondered about in their walks. Families most often wondered why more-than-human species looked a particular way, such as if there was function or purpose to their colorings or structure (37.93% of responses). For example, one family wondered why a tree's branches were grey and bent and included detailed, close-up drawings of the branch. They also noted that the writing and drawing were done by an older sibling still in elementary school, but the observations and questions were dictated from the 2nd grader. This kind of detailed observation and wondering from place-walking is a key practice of field-based science and generated a range of descriptive questions about species and kinds that could lead to investigative questions. Further, this was evidence that families engaged this activity as an intergenerational activity, including siblings, expanding our conceptions of homework, and home-school practices. This type of activity may work to provide alternative to age segregation that continues to impose colonial structures on familial and cultural wellbeing (Rogoff, 2003). Some questions suggested that families were surprised by their observations given either previous experience walking in a place, or given prior knowledge. For example, one family asked why they were observing green leaves on plants during a winter wondering walk. This kind of sensemaking and curiosity has been shown to lead to motivation in science learning and is a key practice in scientific activity.

Figure 4-10 Proportion of more-than-human species' and kinds' behaviors in LEs 2.4 and 4.4 FAMILY WALK



Families also noticed and wondered about particular behaviors of more-than-human species (48.27% of responses), including how they grow and change over time (10.35%), what they eat or need for nutrition (13.79%), and particular actions or movements of more-than-humans (17.24%) such as birds flying and nesting, ants congregating on a sidewalk, or squirrels gathering nuts together. Previous research has shown that young children and families can engage in sophisticated reasoning about the behaviors of more-than-human others (Montaño Nolan, 2016). This finding builds on this research that children and families attend to and engage in scientific questioning about the behaviors of more-than-human others and suggests that routine epistemic practices of place walking may encourage further questioning and investigation.

Finally, families were attuned to spatial dimensions in their observations with 20.69% of behavior/characteristic responses about more-than-human habitats in local places: backyards, neighborhoods, and lands/waters. As discussed previously, families identified these spaces as important to their familial wellbeing in LE 1.3 FAMILY PLACES, and engaged in routine human-centric practices in these places. During these walks, families were attuned to the fact that they also shared these places with

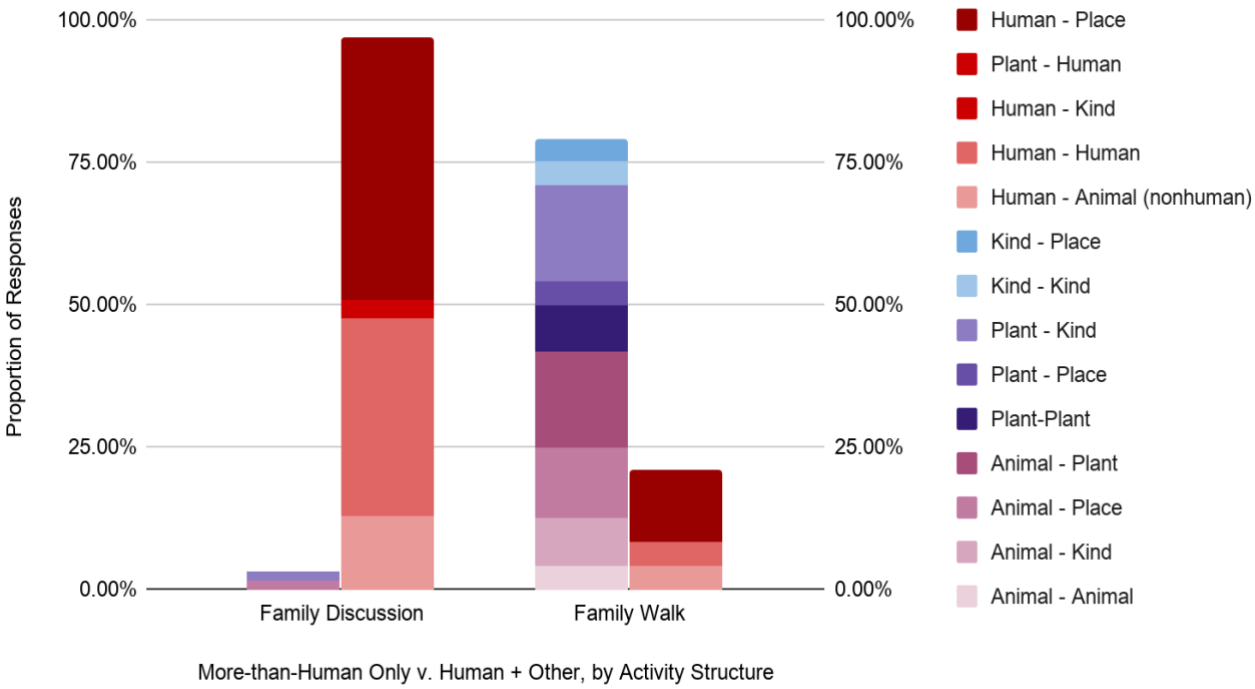
more-than-human others. This may be an important shift in disrupting human-centrism and considering the impacts of human decisions on more-than-human others.

Species and Kinds Relationships. Families also engaged in relational reasoning, noticing and wondering about interactions between species and kinds. I conducted an analysis of base pair relationships in order to characterize the types of relationships that families noticed and wondered about in the responses on the FKPS wondering walk tools. For this analysis I only used written responses as it was difficult to characterize the base relationships in families detailed drawings, particularly those that include more than two types of species or kinds. Future analysis on relational construal in student and family drawings is planned. Families noticed a range of relationships between species-species, species-kind, kind-kind, and species/kind-place in the walks. Strikingly, these findings looked different than my analysis of family discussions. I share a comparative analysis to illustrate how family walks de-centered human dominant frames. **Figure 4-11** shows a comparative analysis between base relationships found in LE 1.3 FAMILY PLACES (n = 29) and LES 2.4 and 4.4 FAMILY WALKS (n = 29). These are divided into more-than human only base pairs (i.e., no humans), and human + other base pairs in order to better visualize differences between proportion of human relations in discussions versus walks.

In family discussions, human relationships with the natural world made up the majority of relationals (96.83% of family discussion relationships responses). The family discussion tool specifically prompted for families to consider their own (i.e. human) relationships with the places and with others who share this place. I believe this facilitated human-centric reasoning about relationships. In contrast, the wondering walks asked families to notice and wonder about anything on their walks in neighborhoods and communities. Human + other relationships were still observed during family walks, but they made up

only 20.83% of relationship responses. Instead, plant and animal relations were the focus of family walks making up more than ⅔ of observations.

Figure 4-11 Proportion of more-than-human species/kinds only and human+other base relations in FAMILY DISCUSSION (LE 1.3) versus FAMILY WALK tools (LE 2.4 and 4.4)



Design Affordances and Constraints of Designed Family Walks. Asking families to engage in field-based science walks in their local neighborhoods, lands, and waters expanded opportunities for families to observe and wonder about socio-ecological phenomena where humans are present, but not the central salient features of the activity. Families observed and asked questions about a range of more-than-human species, their behaviors, and their relationships that are richly linked to NGSS disciplinary core ideas and cross-cutting concepts. These family wondering walks facilitated "questions based on observations to find more information about the designed world" - a kindergarten performance expectation for engagement in scientific practices in the Next Generation Science Standards. Further, such observations robustly supported learning that "there are many different kinds of living things in an area, and they exist in different places on land and in water" - a life sciences disciplinary core idea for

second grade (2-LS4-1). In other words, the FKPS tools mediated attentional patterns to field-based science phenomena that can help meet and extend state science standards in the classroom.

While responses about more-than-human behaviors and relationships increased proportionally in the wondering walks as compared to the family discussion, there was still an emphasis on taxonomic identification of objects, more-than-humans, and humans during walks. The tool first prompts families to identify what they notice, and most families catalogued a few items in list format. Families "noticed" more-than-human species or kind in action - or behaving in a particular way (e.g., birds flying, squirrels gathering nuts). However, this was often focused on singular species, rather than a web of relationships. This kind of taxonomic reasoning or focus on singular species can inhibit complex systems sensemaking (Pugh, 2019). There were promising shifts found in responses to LE 4.4 WONDERING WALK 2, which was designed specifically to scaffold attention towards relational reasoning; however, we only collected nine of these tools, so I provide preliminary claims in this analysis. In particular, I found a proportional increase in observations of more-than-human kinds, as well as relationships between more-than-human species/kinds. This suggests that this type of relational reasoning can be scaffolded; however, the first wondering walk tool (LE 2.4) may not have facilitated such reasoning as foundational for beginning an investigation.

4.7.3. *Limitations and Considerations*

These tools were designed to intervene in broader systems of activity that have historically marginalized and oppressed families and communities of color. As such, we tried to shift multiple activity systems simultaneously. At times, we found movement towards relationality and transformational possibility, at other times we felt conceptual and pragmatic enclosures towards binary or divisive relations. In particular, deficit conceptions about families and the role of families in education continued to infuse the design, implementation, and sensemaking of the FKPS tools even as we reached for relationality. For example, educators routinely questioned whether families could or would complete the FKPS tools as they were designed. At each co-design summit, we heard educators share their experiences with low family participation in classrooms and low return rates of homework assignments as barriers to

the potential use of FKPS tools (field notes, summits 2018-2019). Additionally, while we had modest return rates of FKPS tools, some educators framed this as an "access" issue - meaning, families could not access the content and purpose of such tools (personal field notes, Spring 2020 summit). Educators perceived family dis-engagement broadly, and specifically non-return of these tools, as indicative of the lack of time and consequentiality of science learning to families' lives. These conceptions are pervasive in formal and informal educational environments, such that they have become naturalized in educational discourse, practice, policy, and research (Philip, 2011).

Although still preliminary, we have begun to analyze these FKPS tools in the context of educator praxis, both in their instruction with students and in co-designing mediational materials (i.e., learning engagements curriculum). We saw the focus of design, sensemaking, and curricular planning, at times, became centered on pragmatic constraints of compliance - how can we get families to do these activities and return these tools. I argue this was antithetical to the kinds of transformative home-school practices we sought. Importantly, we also saw transformative potential in the tools that were returned (as exemplified in this paper) and when we provided time and space for teachers to make sense of student and family thinking as connected to disciplinary content, identity development, and professional practice.

4.8. REFLECTIONS AND IMPLICATIONS FOR FAMILY-ENGAGED DESIGN WORK

The purpose of this paper was to expand a model for re-configuring home-school practices in ways that engage students, families, and classrooms in expansive field-based science learning that builds upon the heterogenous knowledges and practices of families. Many school-based approaches to engaging families' rich knowledge systems continue to operate on box-model conceptions of culture that treat culture as individual traits one possesses due to racial/ethnic membership. Such views of culture stagnate authentic engagement of families, as schools rely on essentializing or tokenizing practices (Lee, 2006; Gutiérrez & Rogoff, 2003). This paper sought to intervene in this dynamic by building out a model of home-school relationships where the epistemic practices of families are visiblized and centralized in instruction- that is, what they actually do, not what we expect them to do based on their racial/ethnic membership. Through a design analysis, I explored how our core design propositions - socio-ecological

complex systems sensemaking, nature-culture relations, and field-based science - were concretized in activity and tool design. We contended that engaging students and families in robust disciplinary activity - animated by our design propositions - would lead to expansive and consequential science learning across homes and schools. For this analysis, I played close attention to our core assumptions about mediated cognition in the context of goal-directed activity. Broadly, I explored two key modalities designed in the FKPS tools described in this study: (a) indoor, discursive tool-mediated activity, and (b) mobile, attentional tool-mediated activity, as well as potential design affordances of each. The purpose of the content analysis, then, was to understand these tools-in-use. In particular, I wanted to understand what we can learn from families' knowledges and practices in relation to our core design propositions, and how they can drive science instruction. I found that families using these tools shared deep place-based insights and wonderings that expanded our conceptions of place and demanded increased design attention to how we facilitated science learning across global geographies and temporalities. In the following, I reflect on these findings in light of relational axio-onto-epistemological practices across home and school, as well as share implications for place-based co-design.

Our model aimed to enact axio-onto-epistemological relationality through a process of co-constructing knowledge in a seasonal field-based science storyline. In this storyline, students, educators, families, and community partners collectively design an investigation study that (a) builds upon families heterogenous knowledges and practices, (b) emerges from place-based observation and question-asking; and (c) expands opportunities for individual and collective, as well as social and ecological transformation. We designed for this in myriad ways across the project and throughout the storyline. For this analysis I focused on the knowledge and practice sharing tools as one way that we re-configured home-school practices. Our designs focused on (re)making nature-culture relations through field-based science practices to support complex systems sensemaking and decision-making in places that are important to families. Analysis of these tools revealed how families, particularly the diasporic and immigrant families in this study, are complexly making sense of place-based relationships that reflects

keen attunement to historicized, politicized and powered dynamics across spatial and temporal scales and relations with humans and more-than-humans.

In particular, storying familial relationships to places, lands, and waters can centralize the importance of place-making to scientific activity. This expands notions of science beyond thematic units that are often disconnected from students' daily lives and communities, and instead seeds curiosity about socio-ecological phenomena in places that families feel are important for their wellbeing. While I found many families' place-making practices were anthropocentric (i.e., nature-culture divides), I also found emerging evidence that asking families (a) what they want to know more about, and (b) to reason about this place from other perspectives (i.e., plant and animal time, ethical responsibilities/possibilities) engendered non-anthropocentric reasoning. This suggests that nature-culture complementaries could be facilitated through careful tool design, and routinized in classroom and home activity in places that families dwell. Further, going on wondering walks in neighborhoods and local greenspaces can support attentional habits to complex socio-ecological systems. Through this analysis I found families observed and asked questions about a range of more-than-human behaviors and relationships, as well as the role of humans in these places. These place-emergent observations fueled expansive questions, including how, why, when, and where questions connected to NGSS science standards.

The goal of FKPS activities and tools was to re-configure home-school practices towards curricular co-design, where families and students play a central role in determining their scientific engagement. The FKPS tools designed and analyzed in this study are the launch of a classroom seasonal field-based storyline that builds towards a place-emergent investigation across places, lands, and waters. Rather than predetermined thematic units, these investigations build with and from the interests, observations, questions, stories, practices, and relationships of students and families as they emerge in reflexive and recursive disciplinary activity. The three tool-mediated activities examined in this paper lay the groundwork for such expansive science learning, as grounded in broader theories of social transformation that seeks to simultaneously disrupt inequitable power dynamics and open up new space for learning and creativity.

5. CONCLUSIONS & IMPLICATIONS FOR FAMILIES-ENGAGED IN EDUCATIONAL CHANGEMAKING

"[I]n the face of the magnitude of the force, speed and devastating violence of colonization and interrelated systems of violence, there is an understandable impulse to suppress these contradictions and conflicts in order to collapse decolonization into coherent, normative formulas with seemingly unambiguous agendas. This tendency is only intensified in moments of crises and unpredictability, which can leave little time and few spaces for exploring the complexities, tensions and paradoxes of decolonizing work without an immediate need for resolution, coherence and prescriptive action." - de Oliveira Andreotti et al., 2015, p. 22.

This quote highlights, for me, the urgency with which I and many other justice-seeking mothers, scholars, educators, future-elders, (and on) seek to unravel educational colonial power matrices and knit anew the conditions for social and educational changemaking and thrivance, as well as the vigilance with which we must embrace the tensions and paradoxes as they unfold around us (past, present, and future). Reflecting the desired shift to family-engaged partnership that sustains diverse communities, this dissertation built with many critical scholars who call for ending and repairing/healing from ontological and epistemic violence against nondominant families and students and creating space for axiological innovations to root (e.g., Bang et al., 2016, 2018; Bang & Vossoughi, 2016; Booker & Goldman, 2016; Ishimaru et al., 2019; Jurow et al., 2016). That is reimagining how and why we partner, and "intervening in presumed neutralities and examining how our values, sensibilities, affects, and desires shape what are 'right,' 'good,' 'important,' or 'worthwhile' forms of partnership and work that reflect views of the past, the here-and-now, and imagined futures in the places we dwell" (Bang & Vossoughi, 2016, p.181). I return to and reflect on the findings of this dissertation in relation to the co-design questions posed at the introduction to this dissertation.

1. *How can we co-design expansive learning with and for families that contributes to place-based community wellbeing and educational justice?*
2. *How do binary and relational axio-onto-epistemologies manifest in and across different co-design activity settings where families are engaged in learning and changemaking?*

3. *What heuristics and tools of families engaged in education enable or constrain particular axio-onto-epistemologies to unfold over time?*

The three papers presented in this dissertation took up axio-onto-epistemic relationality as a core condition of family-engaged partnership processes, focusing on co-design partnerships for familial and communal thriving across heterogeneous geographies, intracultural communities, and relations to systemic power. Further, these papers highlighted the complexities of engaging families, particularly nondominant families, in educational systems as the routinized divisions and hierarchies scripted in such interactions unfold in predictable patterns and emerge in unanticipated moments. I return to, and reflect on the findings and implications of these papers in relation to the three questions posed in the introduction to this dissertation. I then turn to a reflection on the contributions of this paper in the moment of global pandemic in which I write.

In paper 1, I focused on characterizing the subject-subject divisions between intracultural families, and between families and education systems actors (i.e., educators, administrators, formal leaders etc.) and how we might reach for relationality. The goal of phase 1 the Family Leadership Design Collaborative was to map the conceptual and relational landscapes of decolonial work in the lived experiences, expertise, and desires of heterogenous communities as a way to disrupt the "understandable impulse" towards singular definitions or select "best practices" for engagement (Ishimaru & Bang, 2016; Ishimaru et al., 2018). Utilizing an ideologies in pieces (Philip, 2011) and conceptual ecologies (Kelly & Green, 1998) approach to examining the kinds of conceptions about families that emerge in our work, I demonstrated that conceptions about families in school-based engagement are steeped in divisive logics; however, these do not remain settled in discourse or practice as co-designers proffered alternative conceptions rooted in care, kinship, cultural thriving educative practices, humility, vulnerability, and relationality. Implications for co-design include expanding our interpretive power (Rosebery et al., 2016) to anticipate settled conceptions of families that mobilize deficit ideologies and practices, and to design for and seed agentic and relational conceptions in partnering processes that can desettle hierarchical and divisive power matrices.

Paper two grappled with designing axio-onto-epistemic relationality between families and educators as they co-designed science learning opportunities for young people, *and* relationality between humans and the places, lands, waters, and more-than-human others upon which science-focused partnerships would take place. In other words, this paper sought to build out a model for family-engaged and place-based co-design partnerships. Through a design analysis of our co-design tools, practices, and processes through the lens of nature-culture complementaries, I identified an ecology of "presencing" practices that sought relationality across these two divides. Further, through a discourse analysis of our designs in use during co-design with families, educators, and community partners, I narrated a series of place-based design commitments to families engaged in education. These included a commitment to partnership that strengthened familial relationships in places, and a desire for expansive learning opportunities that challenge traditional unidirectional learning (i.e., from schools to families, or families to schools). Implications for co-design included expanding design opportunities for families to shape the design of instructional materials and partnership practices in ways that attend to historically accumulated power dynamics *and* in the places that matter to students, families, and educators.

In paper three, I described how we concretized family-engaged partnership practices though a series of co-designed boundary-crossing tools that repair division across home-school physical boundaries. A design analysis demonstrated core commitments to (re)making nature-culture complementaries through engagement in meaningful field-based science practices that support complex systems sensemaking and decision-making. A content analysis revealed that families complexly reason about spatial and temporal relations to places that span local and global contexts. Further, engaging in outdoor, mobile practices supported reasoning about the behaviors and relationships of species and kinds in local places in ways that disrupted human centrism. Importantly, we learned that our designs, at times, underestimated the complexity and sophistication of familial reasoning, particularly as it reflected diasporic and immigrant relations to places over generations. Implications for co-design, then, include explicit attention to how nature-culture complementaries are refracted in tool-mediated activities and ongoing critical reflection to learn and re-design with/from families.

Across these three papers, I explored how relational axiological, ontological, and epistemological dimensions of time and space engenders family-engaged goals that (a) repairs from many decades of harm caused by settler-colonial and racialized aims of family engagement and schooling; (b) affirms and desires heterogeneity, reflexivity, and learning in how educators approach both engagement/partnership work as well as their own teaching practice; and addresses here-and-now communal issues and (re)imagines possible futures through collective changemaking. It is my hope that expanding our interpretive power (Rosebery et al., 2016) to "see" the tensions and paradoxes of families engaged in education as generative for charting the depths of settler-colonial desires for division between schools and families, and between families as well as socially dreaming elsewheres for familial and communal thriving.

I write the closing of this dissertation with my daughters at the table alongside me and reflect on what families-engaged in educational changemaking might mean in the context of a global pandemic that has irrevocably changed the role of families in schooling, and education more broadly. I think with the following quotes from my mentors shared online shortly after the pandemic closed schools nationally.

> "As I write this, over 50 million children are now at home with their families due to school closures. In the wake of COVID-19, it is no longer possible to overlook the role of families in the education and wellbeing of young people. In a profound and sudden way, families have come to the center of conversations about education. At the same time, as so many have noted, the pandemic has not only revealed but deepened racial injustices in our society. Black, Native, and Latinx communities have been hit disproportionately hard by coronavirus; many working class immigrants have been forced to remain in frontline labor or have lost their jobs; those without documentation live with limited access to healthcare, few governmental supports, and constant fear; incidents of anti-Asian racism have increased dramaticall.y" (Ishimaru, 2020)

> As our daily lives are rapidly reconfiguring, how can we be self-determining in the reconfiguration? We need to hold the devastating impacts of this moment, and can we also reach for what might be possible that wasn't visible before? … What if we recognized this moment as also a possibility to reconfigure life towards the world we want? What kinds of new questions would we ask, what kinds of reimagining might we do together? We want to find ways to think with you all about this, and to create spaces in which we can reimagine together." (Nasir & Bang, 2020, May 11)

Conceptions about families and their roles in education – schooling specifically – have become centralized in discourse, policy and practice in the wave of school closures, economic collapse, and heightened racialized divisiveness. This dissertation sheds light on the already fractured and divisive politics that undergird many institutionally-based aims and practices for engaging families in education that are exacerbated in moments of "crisis and unpredictability" (de Oliveira Andreotti et al., 2015, p. 22). As Ishimaru (2020) cautions, two damaging assumptions continue to frame much of the settled expectations and practices shaping the reopening of schools (from pre-school through higher education). These include (a) "we should recreate schools at home;" and (b) "others know what is best for children." These reflect deficit conceptions of families as learners and first teachers in ways that (re)assert schools and school-based actors as expert in the lives of children and their families, and dictate the forms of appropriate characteristics and deferent roles of families in this moment (Doucet, 2011; Nakagawa, 2000). This dissertation also articulates alternative forms of partnership that (a) predicate partnership on familial knowledge and roles as socializers and educators of their children in their own cultural contexts; (b) encourages outdoor, mobile learning in places that families routinely go to support complex systems sensemaking; and (c) expands possibilities for place-based learning and changemaking that do not require "prescriptive action."

Importantly, this dissertation demonstrates that unidirectional learning and changemaking – school to families, or families to school – does not lead to systemic transformation. Rather, decolonial work in this context will likely require vulnerability and ingenuity for co-designing new sets of relations,

tools, and practices that expand axiological commitments to heterogeneity and authentic socio-ecological changemaking; ontological commitments to multiplicities of beinghood and subject-subject relations; and epistemological commitments to learning with families and communities, and on places, lands, and waters. Engeström and colleagues (2011) write that transformation is possible in the "unknown and unpredictable" (p. 622), yet collapse into the settled is also amplified in such times (de Oliveira Andreotti et al., 2015). As I reflect on the knowledges, hopes, and possibilities for new realities that families, educators, and community partners narrated as part of this work, I am filled with a cautious hope for the future.

para la familia
con solidaridad
al futuro

REFERENCES

Adair, J. K. (2019). The role of humility in working with families across international contexts. In C. M. McWayne, F. Doucet, & K. Sheridan (Eds.), *Ethnocultural diversity and the home-to-school link* (pp. 109-122). Springer International Publisher.

Aikenhead, G. S. (2010). Academic science, cultural intransigence, and devious educo-politics. *Cultural Studies of Science Education, 5*(3), 613-619.

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 81*(2), 132-169.

Archibald, J. A. (2008). An indigenous storywork methodology. In, J. G. Knowles & A. L. Cole, (Eds.), *Handbook of the arts in qualitative research: Perspectives, methodologies, examples, and issues* (pp.371-393). Sage Publications, Inc.

Atran, S., & Medin, D. (2008). *The Native mind and the cultural construction of nature*. MIT Press.

Atran, S., Medin, D. L., & Ross, N. O. (2005). The cultural mind: Environmental decision making and cultural modeling within and across populations. *Psychological Review, 112*(4), 744-776.

Auerbach, E. (1995). Deconstructing the discourse of strengths in family literacy. *Journal of Reading Behavior, 27*(4), 643-661.

Auerbach, S. (2007). From moral supporters to struggling advocates: Reconceptualizing parent roles in education through the experience of working-class families of color. *Urban Education, 42*(3), 250-283.

Auerbach, S. (2010). Beyond coffee with the principal: Toward leadership for authentic school–family partnerships. *Journal of School Leadership, 20*(6), 728-757.

Bang, M. (2015). Culture, learning, and development and the natural world: The influences of situative perspectives. *Educational Psychologist, 50*(3), 220–233.

Bang, M., & Marin, A. (2015). Nature–culture constructs in science learning: Human/non-human agency and intentionality. *Journal of Research in Science Teaching, 52*(4), 530–544.

Bang, M., & Nasir, N. S. (n.d.). *An open letter to our community: COVID-19*. Spencer Foundation. https://www.spencer.org/news/an-open-letter-to-the-spencer-community-covid-19

Bang, M., & Vossoughi, S. (2016). Participatory design research and educational justice: Studying learning and relations within social change making. *Cognition & Instruction, 34*(3), 173-193.

Bang, M., Curley, L., Kessel, A., Marin, A., Suzukovich III, E. S., & Strack, G. (2014). Muskrat theories, tobacco in the streets, and living Chicago as Indigenous land. *Environmental Education Research, 20*(1), 37-55.

Bang, M., Faber, L., Gurneau, J., Marin, A., & Soto, C. (2016). Community-based design research: Learning across generations and strategic transformations of institutional relations toward axiological innovations. *Mind, Culture, and Activity, 23*(1), 28-41.

Bang, M., Marin, A., & Medin, D. (2018a). If Indigenous peoples stand with the sciences, will scientists stand with us? *Daedalus, 147*(2), 148-159.

Bang, M., Medin D., Washinawatok K., & Chapman S. (2010) Innovations in culturally based science education through partnerships and community. In M. Khine, & I. Saleh (Eds.), *New science of learning*. Springer.

Bang, M., Montaño Nolan, C., & McDaid-Morgan, N. (2018b) Indigenous family engagement: Strong families, strong nations. In: E. McKinley & L. Smith (Eds.), *Handbook of Indigenous education*. Springer International Publisher.

Bang, M., Tzou, C., Bricker, L., Welch, M., Benita, C., & Siehl, S. (in prep). Complex socio-ecological systems, nature-culture relations, and field-based science: A model for early childhood science education.

Bang, M., Warren, B., Rosebery, A., & Medin, D. (2012). Desettling expectations in science education. *Human Development, 55*(5-6), 302-318.

Banks, J.A., Au, K.H., Ball, A.F., Bell, P., Gordon, E.W., Gutiérrez, K.D., & Zhou, M. (2007). Learning in and out of school in diverse environments: Life-long, life-wide, life-deep. Seattle: LIFE Center and Center for Multicultural Education (University of Washington).

Baquedano-López, P., Alexander, R. A., & Hernández, S. J. (2013). Equity issues in parental and community involvement in schools: What teacher educators need to know. *Review of Research in Education, 37*(1), 149-182.

Barajas-López, F., & Bang, M. (2018). Indigenous making and sharing: Claywork in an Indigenous STEAM program. *Equity & Excellence in Education, 51*(1), 7-20.

Barrueco, S. (2019). Family-school partnership research with the migrant and seasonal farm working community. In C. M. McWayne, F. Doucet, & K. Sheridan (Eds.),, *Ethnocultural diversity and the home-to-school link* (pp. 89-108). Springer International Publisher.

Barton, A. C., & Tan, E. (2019). Designing for rightful presence in STEM: The role of making present practices. *Journal of the Learning Sciences, 28*(4-5), 616-658.

Barton, A. C., Drake, C., Perez, J. G., St. Louis, K., & George, M. (2004). Ecologies of parental engagement in urban education. *Educational Researcher, 33*(4), 3–12.

Bell, P. (2004). On the theoretical breadth of design-based research in education. *Educational Psychologist, 39*(4), 243-253.

Bell, P., Tzou, C., Bricker, L., & Baines, A. D. (2012). Learning in diversities of structures of social practice: Accounting for how, why and where people learn science. *Human Development, 55*(5-6), 269-284.

Berkes, F. (2017). Environmental governance for the anthropocene? Social-ecological systems, resilience, and collaborative learning. *Sustainability, 9*(7), 1232.

Booker, A., & Goldman, S. (2016). Participatory design research as a practice for systemic repair: Doing hand-in-hand math research with families. *Cognition and Instruction, 34*(3), 222-235.

Brayboy, B. M. J. (2005). Toward a tribal critical race theory in education. *The Urban Review, 37*(5), 425-446.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *American Educational Research Association, 18*(1), 32–42.

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Clear Light Pub.

Calderon, D. (2014). Speaking back to Manifest Destinies: A land education-based approach to critical curriculum inquiry. *Environmental Education Research, 20*(1), 24–36.

Carey, S. (1985). *Conceptual change in childhood.* MIT Press.

Carreón, G. P., Drake, C., & Barton, A. C. (2005). The importance of presence: Immigrant parents' school engagement experiences. *American Educational Research Journal, 42*(3), 465-498.

Caspe, M., Woods, T., & Kennedy, J. L. (Eds.),. (2018). *Promising practices for engaging families in STEM learning*. Information Age Publishing.

Chi, M. T. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *The Journal of the Learning Sciences, 6*(3), 271-315.

Chinn, C. A., Buckland, L. A., & Samarapungavan, A. L. A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist, 46*(3), 141-167.

Cole, M., & Engeström, Y. (2007). Cultural-historical approaches to designing for development. In J. Valsiner & A. Rosa (Eds.),, *The Cambridge handbook of sociocultural psychology* (p. 484–507). Cambridge University Press.

Cooper, C. W. (2009). Parent involvement, African American mothers, and the politics of educational care. *Equity & Excellence in Education, 42*(4), 379-394.

Danish, J. A. (2014). Applying an activity theory lens to designing instruction for learning about the structure, behavior, and function of a honeybee system. *Journal of the Learning Sciences, 23*(2), 100-148.

Danish, J. A., & Enyedy, N. (2007). Negotiated representational mediators: How young children decide what to include in their science representations. *Science Education, 91*(1), 1-35.

de Oliveira Andreotti, V., Stein, S., Ahenakew, C., & Hunt, D. (2015). Mapping interpretations of decolonization in the context of higher education. *Decolonization: Indigeneity, Education & Society*, *4*(1), 21-40.

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus*, trans. Brian Massumi. University of Minnesota Press.

DeLiema, D., Lee, V. R., Danish, J. A., Enyedy, N., & Brown, N. J. (2015). A microlatitudinal /microlongitudinal analysis of speech, gesture, and representation use in a student's repeated scientific explanations of phase change. In A. diSessa, M. Levin, N. J. S. Brown (Eds.), *Knowledge and interaction: A synthetic agenda for the learning sciences* (pp. 149-175). Routledge.

Deloria V., & Wildcat, D. R. (2001). *Power and place: Indian education in America*. Fulcrum Publishing.

Deloria, V. (1979). *The metaphysics of modern existence*. Harper & Row.

Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher, 32*(1), 5-8.

diSessa, A. A. (1988). Knowledge in pieces. In G. Forman and P. Pufall (Eds.), *Constructivism in the computer age* (pp. 49–70). Lawrence Erlbaum Associates.

diSessa, A. A. (1993). Toward an epistemology of physics. *Cognition and Instruction, 10*(2-3), 105–225.

Disessa, A. A. (2002). Why "conceptual ecology" is a good idea. In M. Limón & L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp. 28-60). Springer.

diSessa, A., Danish, M., & Brown, N. J. S. (Eds.),. *Knowledge and interaction: A synthetic agenda for the learning sciences*. Routledge.

Doucet, F. (2011). Parent involvement as ritualized practice. *Anthropology & Education Quarterly, 42*(4), 404-421.

Eberbach, C., & Crowley, K. (2009). From everyday to scientific observation: How children learn to observe the biologist's world. *Review of Educational Research, 79*(1), 39-68.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133-156.

Engeström, Y. (2011). From design experiments to formative interventions. *Theory & Psychology, 21*(5), 598-628.

Engeström, Y., Nummijoki, J., & Sannino, A. (2012). Embodied germ cell at work: Building an expansive concept of physical mobility in home care. *Mind, Culture, and Activity, 19*(3), 287-309.

Erickson, F. (1996). Ethnographic microanalysis. In S. L. McKay, & N. H. Hornberger (Eds.), *Sociolinguistics and language teaching* (pp. 283-306). Cambridge University Press.

Esmonde, I., & Booker, A. N. (Eds.). (2016). *Power and privilege in the learning sciences: Critical and sociocultural theories of learning*. Taylor & Francis.

Espinoza, M. L., & Vossoughi, S. (2014). Perceiving learning anew: Social interaction, dignity, and educational rights. *Harvard Educational Review, 84*(3), 285-313.

Family Leadership Design Collaborative. (2017). *Solidarity-driven decision-making: Enacting equity in partnering and decision-making* [Research brief]. University of Washington. https://familydesigncollab.org/wp-content/uploads/2018/07/Solidarity-Driven-Decision-Making_FLDC-Phase-2-Process.pdf

Family Leadership Design Collaborative. (2019). *FLDC by the numbers report* [Research brief]. University of Washington. https://familydesigncollab.org/wp-content/uploads/2020/07/FLDC_By_the_Numbers_December_2019.pdf

Fantuzzo, J., McWayne, C. M., Perry, M. A., & Childs, S. (2004). Multiple dimensions of family involvement and their relations to behavioral and learning competencies for urban, low-income children. *School Psychology Review, 33*(4), 467.

Farhan Ferrari, M., De Jong, C., & Belohrad, V. (2015). Community-based monitoring and information systems (CBMIS) in the context of the Convention on Biological Diversity (CBD). *Biodiversity, 16*(2-3), 1-12.

Fernández, E., & López, G. R. (2017). When parents behave badly: A critical policy analysis of parent involvement in schools. In M.D. Young & S. Diem (Eds.), *Critical approaches to education policy analysis* (pp. 111-129). Springer.

Friedel, T. L. (1999). The role of Aboriginal parents in public education: Barriers to change in an urban setting. *Canadian Journal of Native Education, 23*(2), 139-158.

Fryberg, S. A., & Bang, M. (2018, June 29). Blaming parents of color for their own oppression is an American pastime. *Education Week*. https://www.edweek.org/ew/articles/2018/06/29/blaming-parents-of-color-for-their-own.html

Garces, L. M., Ishimaru, A. M., & Takahashi, S. (2017). Introduction to beyond interest convergence: Envisioning transformation for racial equity in education. *Peabody Journal of Education, 92*(3), 291-293.

Garcia, J. (2014). Re-examining indigenous conceptualizations of family and community involvement. *Journal of Family Diversity in Education, 1(*1), 58-74.

Geronimus, A. T. (2003). Damned if you do: Culture, identity, privilege, and teenage childbearing in the United States. *Social Science & Medicine, 57*(5), 881-893.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics, 32*(10), 1489-1522.

Goodwin, C. (2013). The co-operative, transformative organization of human action and knowledge. *Journal of Pragmatics, 46*(1), 8-23.

Gorenflo, L. J., Romaine, S., Mittermeier, R. A., & Walker-Painemilla, K. (2012). Co-occurrence of linguistic and biological diversity in biodiversity hotspots and high biodiversity wilderness areas. *Proceedings of the National Academy of Sciences, 109*(21), 8032-8037.

Grosfoguel, R. (2011). Decolonizing post-colonial studies and paradigms of political-economy: Transmodernity, decolonial thinking, and global coloniality. *Transmodernity: Journal of Peripheral Cultural Production of The Luso-Hispanic World* https://escholarship.org/uc/item/21k6t3fq

Grotzer, T. A., Kamarainen, A. M., Tutwiler, M. S., Metcalf, S., & Dede, C. (2013). Learning to reason about ecosystems dynamics over time: The challenges of an event-based causal focus. *BioScience, 63*(4), 288-296.

Grotzer, T. A., Solis, S. L., Tutwiler, M. S., & Cuzzolino, M. P. (2017). A study of students' reasoning about probabilistic causality: Implications for understanding complex systems and for instructional design. *Instructional Science: An International Journal of the Learning Sciences, 45*(1), 25-52.

Gruenewald, D. A. (2003). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal, 40*(3), 619-654.

Gutiérrez, K. D., & Jurow, A. S. (2016). Social design experiments: Toward equity by design. *Journal of the Learning Sciences, 25*(4), 565-598.

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), 19-25.

Gutiérrez, K. D., & Vossoughi, S. (2010). Lifting off the ground to return anew: Mediated praxis, transformative learning, and social design experiments. *Journal of Teacher Education, 61*(1-2), 100-117.

Hall, R., Shapiro, B. R., Hostetler, A., Lubbock, H., Owens, D., Daw, C., & Fisher, D. (2020). Here-and-then: Learning by making places with digital spatial story lines. *Cognition and Instruction, 38*(3)1-26.

Hall, S. (1982). The rediscovery of "ideology": Return of the repressed in media studies. In M. Gurevitch, T. Bennet, J.
Curran, & J. Wollacott (Eds.), *Culture, society and the media* (pp. 56–90). Methuen.

Hall, S. (1996). The problem of ideology: Marxism without guarantees. In D. Morley & K. Chen (Eds.), *Stuart Hall:*
Critical dialogues in cultural studies (pp. 25–46). Routledge.

Hanuscin, D., Lipsitz, K., Cisterna-Alburquerque, D., Arnone, K. A., van Garderen, D., de Araujo, Z., & Lee, E. J. (2016). Developing coherent conceptual storylines: Two elementary challenges. *Journal of Science Teacher Education, 27*(4), 393-414.

Harris, C. I. (1993). Whiteness as property. Harvard law review, 1707-1791.

Hart, B., & Risely, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Paul H Brookes Publishing.

Hayes, M. L., Plumley, C. L., Smith, P. S., & Esch, R. K. (2017). *A review of the research literature on teaching about interdependent relationships in ecosystems to elementary students* [Research brief]. Horizon Research, Inc.

Headrick Taylor, K. (2017). Learning along lines: Locative literacies for reading and writing the city. *Journal of the Learning Sciences, 26*(4), 533-574.

Henderson, A. T., & Mapp, K. L. (2002). *A new wave of evidence: The impact of school, family, and community connections on student achievement*. National Center for Family & Community Connections with Schools, Southwest Educational Development Lab.

Hmelo-Silver, C. E., Jordan, R., Eberbach, C., & Sinha, S. (2017). Systems learning with a conceptual representation: a quasi-experimental study. *Instructional Science, 45*(1), 53-72.

Hmelo-Silver, C., & Azevedo, R. (2006). Understanding complex systems: Some core challenges. *The Journal of the Learning Sciences, 15*(1), 53-61.

Hmelo-Silver, C. E., & Pfeffer, M. G. (2004). Comparing expert and novice understanding of a complex system from the perspective of structures, behaviors, and functions. *Cognitive science, 28*(1), 127-138.

Ishimaru, A. M. (2019). From family engagement to equitable collaboration. *Educational Policy, 33*(2), 350–385.

Ishimaru, A. M. (2020, May 11). *The prospects for just schools in the wake of COVID-19 responses.* [Online blog post] Teachers College Press. https://www.tcpress.com/blog/prospects-schools-wake-covid-19-responses/

Ishimaru, A. M., & Bang, M. (2016). *Toward a transformative research and practice agenda for racial equity in family engagement*. Seattle, WA: Family Leadership Design Collaborative. http://familydesigncollab.org/fldc-convening-report-2015/

Ishimaru, A. M., & Takahashi, S. (2017). Disrupting racialized institutional scripts: Toward parent–teacher transformative agency for educational justice. *Peabody Journal of Education, 92*(3), 343-362.

Ishimaru, A. M., Barajas-López, F., & Bang, M. (2015). Centering family knowledge to develop children's empowered mathematics identities. *Journal of Family Diversity in Education, 1*(4), 1-21.

Ishimaru, A. M., Rajendran, A., Montaño Nolan, C., & Bang, M. (2018). Community design circles: Co-designing justice and wellbeing in family-community-research partnerships. *Journal of Family Diversity in Education, 3(2), 38-63.*

Ishimaru, A. M., Rajendran, A., Montaño Nolan, C., & Bang, M. (in prep). Conceptualizing racial equity in K-12 school-centered family engagement.

Ishimaru, A. M., Torres, K. E., Salvador, J. E., Lott, J., Cameron Williams, D. M., & Tran, C. (2016). Reinforcing deficit, journeying toward equity. *American Educational Research Journal, 53,* 850–882.

Ishimaru, A.M., Bang, M., Valladares, M.R., Montaño Nolan, C., Tavares, H., Rajendran, A., & Chang, K. (2019). *Recasting families and communities as co-designers of education in tumultuous times*. Boulder, CO: National Education Policy Center. http://nepc.colorado.edu/publication/family-leadership

Jeynes, W. H. (2005). A meta-analysis of the relation of parental involvement to urban elementary school student academic achievement. *Urban education, 40*(3), 237-269.

Jurow, A. S., Teeters, L., Shea, M., & Van Steenis, E. (2016). Extending the consequentiality of "invisible work" in the food justice movement. *Cognition and Instruction, 34*(3), 210-221.

Kelly, G. J., & Green, J. (1998). The social nature of knowing: Toward a sociocultural perspective on conceptual change and knowledge construction. In B. Guzzetti, & C. Hynd (Eds.), *Perspectives on conceptual change: Multiple ways to understand knowing and learning in a complex world* (pp. 145-181). Routledge.

Kovach, M. (2010). Indigenous methodologies: Characteristics, conversations, and contexts. University of Toronto Press.

Kuchirko, Y. (2019). On differences and deficits: A critique of the theoretical and methodological underpinnings of the word gap. *Journal of Early Childhood Literacy, 19*(4), 533-562.

Ladson-Billings, G., & Tate, W. F. (2006). Toward a critical race theory of education. In A. D. Dixon & C. K. Rousseau (Eds.),, *Critical race theory in education: All God's children got a song.* Routledge

Lareau, A., & Horvat, E. M. (1999). Moments of social inclusion and exclusion race, class, and cultural capital in family-school relationships. *Sociology of Education, 72*(1), 37-53.

Lawrence-Lightfoot, S. (2003). *The essential conversation: What parents and teachers can learn from each other.* Random House.

Leander, K. M., & Rowe, D. W. (2006). Mapping literacy spaces in motion: A rhizomatic analysis of a classroom literacy performance. *Reading Research Quarterly, 41*(4), 428-460.

Learning in Places Collaborative. (2020a). *Framework: Nature-culture relations*. Bothell, Seattle, WA & Evanston, IL: Learning in Places. http://learninginplaces.org/wp-content/uploads/2020/07/framework_nature_culture.pdf

Learning in Places Collaborative. (2020b). *Framework: Complex socio-ecological systems*. Bothell, Seattle, WA & Evanston, IL: Learning in Places. http://learninginplaces.org/wp-content/uploads/2020/08/framework_complex-socioecological-systems.pdf

Learning in Places Collaborative. (2020c). *Framework: Socio-ecological histories of places*. Bothell, Seattle, WA & Evanston, IL: Learning in Places. http://learninginplaces.org/wp-content/uploads/2020/08/framework_histories_of_place_REV062520.pdf

Learning in Places Collaborative. (2020d). *Framework: Relationships in socio-ecological systems*. Bothell, Seattle, WA & Evanston, IL: Learning in Places. http://learninginplaces.org/wp-content/uploads/2020/08/framework_Relationships.pdf

Lee, C. D. (2008). The centrality of culture to the scientific study of learning and development: How an ecological framework in education research facilitates civic responsibility. *Educational Researcher, 37*(5), 267.

Lehmann, S. (2010). *The principles of green urbanism: Transforming the city for sustainability*. London: Earthscan.

Libby, L. K., Shaeffer, E. M., & Eibach, R. P. (2009). Seeing meaning in action: A bidirectional link between visual perspective and action identification level. *Journal of Experimental Psychology: General, 138*(4), 503.

López, G. R., Yanagui, A., & Kuttner, P. J. (2017, April 27-May 1). What does partnership taste like? : Reimagining family-school partnerships through participatory design research. In A. Ishimaru & M. Bang (Chairs), *Co-Designing family and community wellness and educational justice: Findings from the Family Leadership Design Collaborative* [Symposium]. American Education Research Association Annual Conference, San Antonio, TX, United States.

Madden, B., Higgins, M., & Korteweg, L. (2013). "Role models can't just be on posters": Re/membering barriers to Indigenous community engagement. *Canadian Journal of Education, 36*(2), 212-247.

Marin, A. M. (2013). *Learning to attend and observe: Parent-child meaning making in the natural world.* (Publication No. 3605744) [Doctoral dissertation, Northwestern University]. ProQuest Dissertations and Theses Global.

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.

Marin, A., Bang, M., & Montaño Nolan. (2018). Community-based place designing: Innovations in design practices for expansive science education. In J. Meléndez (Chair), *Community-based design partnerships: Examples from a new generation of CHAT/DBR*. [Symposium]. International Society for the Learning Sciences, London, U. K.

Marin, A., Medin, D., & ojalehto, B. (2017). Conceptual change, relationships, and cultural epistemologies. In T. G. Amin, & O. Levrini (Eds.), *Converging perspectives on conceptual change: Mapping an emerging paradigm in the Learning Sciences* (pp. 43-50). Taylor and Francis.

Marker, M. (2006). After the Makah whale hunt: Indigenous knowledge and limits to multicultural discourse. *Urban Education, 41*(5), 482-505.

Massey, D. (2005). *For space*. Sage Publications Incorporated.

McWayne, C. M., Doucet, F., & Mistry, J. (2019). Family-school partnerships in ethnocultural communities: Reorienting conceptual frameworks, research methods, and intervention efforts by rotating our lens. In C. M. McWayne, F. Doucet, & K. Sheridan (Eds.), *Ethnocultural diversity and the home-to-school link* (pp. 1-18). Springer International Publisher.

Medin, D. L., & Bang, M. (2014a). *Who's asking?: Native science, western science, and science education*. MIT Press.

Medin, D. L., & Bang, M. (2014b). The cultural side of science communication. *Proceedings of the National Academy of Sciences, 111(Supplement 4)*, 13621-13626.

Medin, D., ojalehto, B., Marin, A., & Bang, M. (2014). Culture and epistemologies: Putting culture back into the ecosystem. In M. J. Gelfand, C. Y. Chiu, & Y. Y. Hong (Eds.), *Advances in culture and psychology* (p. 177–217). Oxford University Press.

Medin, D., Ross, N., Cox, D., & Atran, S. (2007). Why folkbiology matters: Resource conflict despite shared goals and knowledge. *Human Ecology, 35*(3), 315-329.

Mediratta, K., Shah, S., & McAlister, S. (2009). *Community organizing for stronger schools: Strategies and successes*. Harvard Education Press.

Meixi. (2019). *Storywork across the landscapes of home and school: Towards Indigenous futures in Thailand* (Publication No. 27665454) [Doctoral dissertation, University of Washington]. ProQuest Dissertations and Theses Global.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th edition). John Wiley and Sons, Inc.

Mignolo, W. D. (2007). Delinking: The rhetoric of modernity, the logic of coloniality and the grammar of de-coloniality. *Cultural studies, 21*(2-3), 449-514.

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice, 31*(2), 132-141.

Montaño Nolan, C. (2016). *If you don't want to leave him out, go ahead": Constructing belonging of non-native animals during Native American parent-child dyad with a diorama* (Publication No. 10138800) [Master's thesis, University of Washington]. ProQuest Dissertation and Theses Global.

Montaño Nolan, C. (2019, November, 1). *A nature-culture conceptual ecology in Native early science* [Poster presentation]. University of Washington College of Education Research and Inquiry Symposium. Seattle, WA.

Nakagawa, K. (2000). Unthreading the ties that bind: Questioning the discourse of parent involvement. *Educational Policy, 14*(4), 443-472.

Nasir, N. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research, 76*(4), 449-475.

Nasir, N. S., Lee, C. D., Pea, R., & McKinney de Royston (Eds.). (2020). *Handbook of the cultural foundations of learning.* Routledge.

National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn II: Learners, context, and cultures*. The National Academies Press.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Committee on a conceptual framework for new K-12 science education standards*. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Nolen, S. B., Wetzstein, L., & Goodell, A. (2020). Designing material tools to mediate disciplinary engagement in environmental science. *Cognition and Instruction, 38*(2), 179-223.

Nxumalo, F., & Cedillo, S. (2017). Decolonizing place in early childhood studies: Thinking with Indigenous onto-epistemologies and Black feminist geographies. *Global Studies of Childhood, 7*(2), 99-112.

Olsson, P. & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken Watershed, Sweden. *Ecosystems, 4*(2), 85–104.

Philip, T. M. (2011). An "ideology in pieces" approach to studying change in teachers' sensemaking about race, racism, and racial justice. *Cognition and Instruction, 29*(3), 297-329.

Philip, T. M., Bang, M., & Jackson, K. (2018). Articulating the "how," the "for what," the "for whom," and the "with whom" in concert: A call to broaden the benchmarks of our scholarship. *Cognition & Instruction, 36*(2), 83-88.

Pugh, P. (2019). *Spatial indexing: An interactional, conceptual, and mediational analysis* (Publication No. 27670020) [Doctoral dissertation, University of Washington]. ProQuest Dissertations and Theses Global.

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,* 1-24.

Reardon, J., & TallBear, K. (2012). "Your DNA is our history" genomics, anthropology, and the construction of Whiteness as property. *Current Anthropology, 53*(5), 233-245.

Reiser, B. J., Novak, M., & McGill, T. A. (2017, June 27). Coherence from the students' perspective: Why the vision of the framework for K-12 science requires more than simply "combining" three dimensions of science learning. In *Instructional materials for the Next Generation Science Standards* [Workshop]. Board on Science Education Workshop.

Rogoff, B. (2003). *The cultural nature of human development*. Oxford University Press.

Rogoff, B., Najafi, B., & Mejía-Arauz, R. (2014). Constellations of cultural practices across generations: Indigenous American heritage and learning by observing and pitching in. *Human Development, 57*(2-3), 82-95.

Romero Manrique de Lara, D., & Corral, S. (2017). Local community-based approach for sustainable management of artisanal fisheries on small islands. *Ocean & Coastal Management, 142*(15), 150–162.

Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as fundamental to learning. *The Journal of the Learning Sciences, 19*(3), 322-357.

Rosebery, A. S., Warren, B., & Tucker-Raymond, E. (2016). Developing interpretive power in science teaching. *Journal of Research in Science Teaching, 53*(10), 1571-1600.

Ross, N., Medin, D., & Cox, D. (2007). Epistemological models and culture conflict: Menominee and Euro-American hunters in Wisconsin. *Ethos, 35*(4), 478-515.

Sanders, K., & Molgaard, M. (2019). Considering race within early childhood education: A misunderstood and underexplored element of family-school partnerships in child care. In C. M. McWayne, F. Doucet, & K. Sheridan (Eds.), *Ethnocultural diversity and the home-to-school link* (pp. 19-36). Springer International Publisher.

Sannino, A., Engeström, Y., & Lemos, M. (2016). Formative interventions for expansive learning and transformative agency. *Journal of the Learning Sciences, 25*(4), 599-633.

Schutz, A. (2006). Home is a prison in the global city: The tragic failure of school-based community engagement strategies. *Review of educational Research, 76,* 691-743.

Schwarz, C. V., Passmore, C., & Reiser, B. J. (Eds.), (2017). *Helping students make sense of the world using next generation science and engineering practices.* National Science Teaching Association Press.

Sheridan, S. M., & Kim, E. M. (Eds.). (2015). *Processes and pathways of family-school partnerships across development* (Vol. 2). Springer International Publishing.

Sherry-Wagner, J., Bang, M., & Tzou, C. T. (in preparation). Wondering in places: Ethics, observation, and field-based science.

Shirley, D. (1997). *Community organizing for urban school reform*. University of Texas Press.

Shirley, V. J. (2017). Indigenous social justice pedagogy: Teaching into the risks and cultivating the heart. *Critical Questions in Education, 8*(2), 163-177.

Simpson, L. B. (2014). Land as pedagogy: Nishnaabeg intelligence and rebellious transformation. *Decolonization: Indigeneity, 3*(3), 1– 25.

Smith, L. T. (2013). *Decolonizing methodologies: Research and indigenous peoples*. Zed Books Ltd.

Sperry, D. E., Sperry, L. L., & Miller, P. J. (2019). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development, 90*(4), 1303-1318.

Squire, V., & Darling, J. (2013). The “minor” politics of rightful presence: Justice and relationality in city of sanctuary. *International Political Sociology, 7*(1), 59-74.

Subramaniam, K. (2018). An exploratory study of student teachers’ conceptions of teaching life science outdoors. *Journal of Biological Education, 53*(4), 399-411.

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological Review, 110*(3), 403.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society*, 1(1), 1-40.

Tuck, E., McKenzie, M., & McCoy, K. (2014). Land education: Indigenous, post-colonial, and decolonizing perspectives on place and environmental education research. E*nvironmental Education Research, 20*(1), 1-23.

Tzou, C., & Bell, P. (2010). Micros and me: Leveraging home and community practices in formal science instruction. In K. Gomez, L. Lyons, & J. Radinsky (Eds.), *Learning in the disciplines: Proceedings of the 9th International Conference of the Learning Sciences* (Vol. 1, pp. 1127-1134). International Society of the Learning Sciences.

Tzou, C., Meixi, Suárez, E., Bell, P., LaBonte, D., Starks, E., & Bang, M. (2019). Storywork in STEM-Art: Making, materiality and robotics within everyday acts of indigenous presence and resurgence. *Cognition and Instruction, 37*(3), 306-326.

Vakil, S., McKinney de Royston, M., Suad Nasir, N. I., & Kirshner, B. (2016). Rethinking race and power in design-based research: Reflections from the field. *Cognition and Instruction, 34*(3), 194-209.

Valdés, G. (1996). *Con respeto: Bridging the distances between culturally diverse families and schools: An ethnographic portrait*. Teachers College Press.

Valencia, R. & Black, M. (2002). “Mexican-Americans don’t value education!” – On the basis of the myth, mythmaking, and debunking. *Journal of Latinos and Education, 1*(2), 81-103.

Veracini, L. (2011). Introducing: Settler colonial studies. *Settler Colonial Studies*, 1(1), 1-12.

Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review, 86*(2), 206-232.

Vrasti, W., & Dayal, S. (2016). Cityzenship: Rightful presence and the urban commons. *Citizenship Studies, 20*(8), 994–1011.

Vygotsky, L. S. (1962). *Thought and language*. M.I.T. Press.

Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A. S., & Hudicourt-Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense-making. *Journal of Research in Science Teaching, 38*(5), 529-552.

Warren, B., Vossoughi, S., Rosebery, A. S., Bang, M., & Taylor, E. V. (2020). Multiple ways of knowing*: Re-imagining disciplinary learning. In N. S. Nasir, C. D. Lee, R. Pea, M. McKinney de Royston, *Handbook of the cultural foundations of learning* (pp. 277-294). Routledge.

Warren, M. R., Mapp, K. L., & the Community Organizing and School Reform Project (2011). *A match on dry grass: Community organizing as a catalyst for school reform*. Oxford University Press.

Warren, M. R., Park, S. O., & Tieken, M. C. (2016). The formation of community-engaged scholars: A collaborative approach to doctoral training in education research. *Harvard Educational Review, 86*, 233-260.

Wertsch, J. V. (1994). The primacy of mediated action in sociocultural studies. *Mind, Culture, and Activity, 1*(4), 202-208.

Whyte K. P. (2013). Justice forward: Tribes, climate adaptation and responsibility. In: Maldonado J.K., Colombi B., Pandya R. (Eds.), *Climate change and Indigenous peoples in the United States*. Springer.

Whyte, K. L. (2015). "They come from chaos:" Considering the power of stories in home-school relationships. *Journal of Family Diversity in Education, 1*(4), 86–105.

Wilson, C. M., Hanna, M. O., & Li, M. (2019). Imagining and enacting liberatory pedagogical praxis in a politically divisive era. *Equity & Excellence in Education, 52*(2-3), 346-363.

Wolfe, P. (2006). Settler colonialism and the elimination of the Native. *Journal of Genocide Research, 8*(4), 387-409.

Yoon, S. A., & Hmelo-Silver, C. (2017). Introduction to special issue: Models and tools for systems learning and instruction. *Instructional Science, 45*(1), 1-4.

APPENDICES

Appendix 2A: Summary of FLDC Design Collaboratives

DC #	CENTRAL AIM OF THE COLLABORATIVE	SUMMARY OF CO-DESIGNER DEMOGRAPHICS		LANGUAGES SPOKEN
		Facilitators [a]	**Co-Design Participants** [b]	
1	Building Cross-Race/Cultural Parenting Solidarities, Central Rhode Island This Design Collaborative brought together parents and researchers in a small, low-income, linguistically and culturally diverse New England district. Parents narrated and worked to challenge deficit-based mindsets that place blame or judge different parenting practices and envision collective parenting approaches towards community well-being.	"Ms. Rodriguez" Dominican immigrant, mother, University researcher (translator for design circle 1) 1 White, female University researcher	6 Latina 1st and 2nd generation immigrant) mothers & grandmother 1 white mother 1 Latino male translator – Spanish & Portuguese (design circle 3 only)	English Spanish Portuguese
2	Building Global Indigeneity, Northeastern Illinois This Design Collaborative took up global Indigenous identities and building solidarities across multiple Indigenous communities. Parents and community leaders explored how they might "bend the river" - or engage intergenerational change from a historicized view without rejecting or only seeing negative histories.	2 Indigenous community members, both women (Black/Choctaw; Sicangu Lakota/Puerto Rican), both University researchers 1 Iranian American, female, University researcher	4-6 adult intertribal community members and leaders, identifying as parents, aunties/uncles, grandparents, and mentors 2 intertribal youth	English Hawai'ian

3	Toisanese Dreams Reshaping Schools, Western Washington In this Design Collaborative, Toisanese families used data from a community survey of families' experiences with the local Public Schools and their own stories to identify and advocate with city and district staff for policy changes to enable families to communicate their dreams and needs for their children, their children's education, and their children's schools.	2 Chinese American community/staff members of community orgs, both female 1 Japanese American community/staff member of community org, female 1 Tawainese American community member/University researcher, male	15-20 immigrant Chinese American parents, predominately mothers	Toisanese Cantonese Mandarin English
DC #	**CENTRAL AIM OF THE COLLABORATIVE**	**Facilitators**	**Co-Design Participants**	**LANGUAGES SPOKEN**
4	Community Organizing Research, Eastern Michigan This Design Collaborative brought together community members and university researchers to not only learn how to better evaluate and marshal educational data to lobby for school improvement, but also connect community organizing strategies to research in a larger effort to utilize research practices in their organizing.	3 African American, female university researchers	7 adult community members, African American, Latinx, and white (2 males) 1 African American youth	English

APPENDIX 2A: SUMMARY OF FLDC DESIGN COLLABORATIVES

5	Collaborating to Support Early Child Education, Eastern Mississippi This Design Collaborative brought together early childhood, P-12, and higher education administrators and educators from federal, state, city, and community institutions to increase participation in early childhood education in Greenville and support teachers involved in early childhood education to share resources, tap community resources to support families, and address a long history of state underfunding, which perpetuates the disenfranchisement of rural black communities.	"Ms. Jones" African American community leader, female	19, female, predominately African American daycare providers, Head Start and public school district teachers, program directors and district administrators "Ms. Thomas" African American university faculty	English
6	Humanizing Parent-Teacher Interactions, Southern California This Design Collaborative reimagined moment-to-moment parent-teacher interactions towards more humanizing relationships in work to address racism and disproportionality in disciplinary policies and actions in the school system.	1 Asian American, female, community leader 1 Latina, university researcher	6 Latinx & African American family members (1 father, 4 mothers, 1 grandmother) 1 Latino staff member 1 Latina translator	Spanish English
DC #	**CENTRAL AIM OF THE COLLABORATIVE**	**Facilitators**	**Co-Design Participants**	**LANGUAGES SPOKEN**
7	Social Justice in an Iranian School Context, North Eastern Illinois This design circle sought to envision, design, and sustain a community-based educational setting that supports Iranian diaspora youth and families, particularly in the current context of racism and Islamaphobia.	1 Iranian American, female, university researcher	8 Iranian immigrant parents and grandparents 1 Iranian American youth	Farsi English

APPENDIX 2A: SUMMARY OF FLDC DESIGN COLLABORATIVES

DC #	CENTRAL AIM OF THE COLLABORATIVE	Facilitators	Co-Design Participants	LANGUAGES SPOKEN
8	Family-School Collaboration to Support Immigrant Communities, Northeastern Oregon This set of design circles brought together families, community organizers, and school district personnel to address Latinx parents' experiences and struggles to support their children, particularly in the current political climate. They discussed aggressions faced by their community and children in schools and sought to explore how schools protect Latinx students and address the fear experienced by many.	4 Latinx community leaders (3 female, 1 male) 1 Latino university researcher	3-7 Latinx parents (mix mothers and fathers)	Spanish
9	Re-imagining School Community Councils, Central Utah This set of design circles brought Latinx parents, community leaders, and school and district staff together to re-envision the purpose and function of an existing school-based resource and decision-making body, School Community Councils (SCCs), to better serve community needs.	2 university researchers, male (Latino; white) 1 Latina district staff member 1 Latina community leader	10-12 Latinx, immigrant parents 10-12 white and Latinx educators from various levels of the K-12 system: administrators, counselors, teachers, and family advocates	Spanish English

APPENDIX 2A: SUMMARY OF FLDC DESIGN COLLABORATIVES

10	Shifting from "Position-ship" to "Relationship" in School Leadership - Family Interactions, Eastern Michigan Acknowledging that the quality of interactions between school leadership and families is critical for cultivating a welcoming and engaging relationship between families and their schools. These design circles bring together principals and parents in the Public School district to address the unequal power dynamics and to co-develop a framework for a true relationship built on mutual trust and respect.	1 African American, male, school district leader	8-10 African American mothers including "Ms. Nora" and "Ms. Olive" 6 school administrators, predominantly African American (2 males), including "Ms. Dinah"	English

Notes.

a. Design collaborative facilitators were self-selected from the family leadership design collaborative network (Ishimaru et al., 2018).

b. Participation varied across each design circle within each collaborative. This column indicates range of participation across the 3-4 design circles.

Appendix 3A: Coding Scheme Design Practices and Activity Structures

CATEGORY OF DESIGN PRACTICES	DESIGN PRACTICE CODE	DEFINITION/EXAMPLE	DESIGN INTENTION
Designing for Physical Presence	Addressing space/time pragmatics	Holding co-design when families can be physically present; specifying times set for families to join; requesting "best" times for families	Decrease space/time barriers for working families
	Recruiting whole families	Inviting whole families and friends to attend; translation, food, activities	Increase opportunities for multi-generational family participation, increase opportunities for groups of families (rather than individual representatives)
	Making explicit contributions	Keeping children present during co-design/providing activities for children	Enable child-led learning and feedback on design processes; refuse segregation of children from learning design and decision-making
Designing for Conceptual Presence	Facilitating role porosity	Inviting everyone to share and leverage multiple forms of expertise and roles with children, families, teaching/learning, gardening, etc.	Recognizing we are all parts of families and communities, lands & waters; web of relations rather than singular identities or positionalities; make visible ranges of cultural knowledges and practices in relation to our roles and daily lives in the places we live
	Framing big ideas	Framing and enfleshing our core commitments across the rhizome; connecting these to "expert" thinking across multiple disciplinary fields and family & community knowledges/practices	Set into motion semiotic landscapes for nature-culture relationality and give them flesh through stories, examples, and shared sensemaking - including how race, class, gender normativity, etc frame family engagement models

APPENDIX 3A: CODING SCHEME of DESIGN PRACTICES AND ACTIVITY STRUCTURES

CATEGORY OF DESIGN PRACTICES	DESIGN PRACTICE CODE	DEFINITION/EXAMPLE	DESIGN INTENTION
Designing for Conceptual Presence (cont.)	Sharing histories of places	Presencing families and communities of the lands, waters, and places where we co-design	Model how to make sense of spatial and temporal dimensions of this place across multiple perspectives, including plant-animal; nation-state; and ethical possibilities/responsibilities of the people who dwell (past, present, and future) in this place where we are designing
	Discussing recruitment strategies	Recruiting families; designing recruitment strategies for classroom, summer programming, and project learning (for those who are not yet here)	Re-mediate family engagement models from deficit-framing, assimilative demands towards partnership and collaboration
Designing for Knowledge-And-Practice Making	Thinking with data & big ideas	Collectively looking at student and family artifacts, transcripts, research briefs, etc.	Giving people time and space to make sense of how big ideas are living in everyday sensemaking of students and families; data informed theorizing and designing
	Storying	Inviting personal and communal stories related to the big ideas	Engaging with stories to theorize and design; identifying local design challenges and solutions reflective of co-designers lived realities
	Rehearsing/piloting	Trying out the practices of complex socio-ecological sensemaking & field-based science *with* families (both together and b/w co-design days)	Trying our designs with co-designers to iteratively refine objectives, tools, and practices; engage in indoor and outdoor activity
	Designing objectives	Sharing dreams and ideas about the end goals - learning objectives, partnering processes, equity/equality outcomes, etc.	Ensuring our design objectives reflect the desires and needs of local co-designers and broader movements towards equity and educational justice
	Designing tools and pedagogical strategies	Designing and re-designing particular tools and practices for teaching, learning, and partnering.	Engaging co-designers in designing solutions to challenges emergent from their activity systems

APPENDIX 4A: TIMELINE OF MAJOR CO-DESIGN ACTIVITY RELATED TO FAMILY TOOL DESIGN

Appendix 4A: Timeline of Major Co-Design Activity Related to Family Tool Design

TIME PERIOD	CO-DESIGN ACTIVITY	GOALS OF CO-DESIGN	PARTICIPANTS
Jan - April 2018	Weekly research meetings	Draft LE 2.2: FAMILY WALK 1, v1 tool	Core research team
April 2018	Quarterly co-design summit	Elicit place-based feedback on LE 2.2: FAMILY WALK 1, v1	Core research team 3 school design teams: Mountain View, Creekside, and Lighthouse Community org design team Interested families (not members of design teams)
April - October 2018	Weekly research meetings	Re-design LE 2.2: FAMILY WALK 1, v1 based on feedback	Core research team
October 2018	Quarterly co-design summit	Elicit place-based feedback on LE 2.2: FAMILY WALK 1, v2	Core research team 2 school design teams: Creekside and Parkview Community org design team
October 2018-January 2019	Weekly research meetings Implementation of wondering walk 1, v2	Support broader family engagement frameworks and programming	Core research team 2 school design teams: Creekside and Parkview
January 2019	Quarterly co-design summit	Professional development and elicitation of family engagement frameworks	Core research team 2 school design teams: Creekside and Parkview Community org design team Interested families (not members of design teams)
January 2019-May 2019	Weekly design meetings Implementation of: LE 2.2 FAMILY WALK 1, v2 + storyline Teacher-made tool: Interest survey	Analysis of 1st implementation of LE 2.2: FAMILY WALK 1, v2 Draft LE 4.4 FAMILY WALK 2, v1 Draft LE 1.3 FAMILY PLACES, v1 Redesign LE 2.2 FAMILY WALK 1, v3	Core research team 1 school design team (Creekside)

APPENDIX 4A: TIMELINE OF MAJOR CO-DESIGN ACTIVITY RELATED TO FAMILY TOOL DESIGN

TIME PERIOD	CO-DESIGN ACTIVITY	GOALS OF CO-DESIGN	PARTICIPANTS
May 2019	Quarterly co-design session	Collective sensemaking of LE 2.2: FAMILY WALK 1, v2 implementation Elicit place-based feedback on: LE 1.3 FAMILY PLACES, v1 LE 2.2 FAMILY WALK 1, v3 LE 4.4 FAMILY WALK 2, v1	Core research team 2 school design teams: Creekside and Parkview Community org design team
May- July 2019	Weekly design meetings Implementation of LE 4.4 FAMILY WALK 2, v1 +storyline (through June 2019)	Support end of year investigations Finalize LE 2.2 FAMILY WALK 1, v3 Draft LE 1.8 FAMILY SEASONS, v1 Draft LE 5.1 FAMILY SHOULD WE, v1	Core research team 1 school design team (Parkside)
July 2019	Quarterly co-design summit (5 day)	Elicit place-based feedback on LE 5.1 FAMILY SHOULD WE, v1	Core research team 2 school design teams: Creekside and Parkview Community org design team
Sept-October 2020	Weekly design meetings Implementation of: LE 1.3 FAMILY PLACES, v1 LE 1.8 FAMILY SEASONS, v1	Redesign LE 1.3 HISTORIES OF PLACE, v2 Analysis of 1st implementation of LE 1.3 FAMILY PLACES, v1	Core research team 2 school design teams: Creekside and Parkview
October 2019	Quarterly co-design summit	Collective sensemaking of LE 1.3 FAMILY PLACES, v1	Core research team 2 school design teams: Creekside and Parkview Community org design team
October 2019 - January 2020	Weekly design meetings Monthly co-design sessions at each school LE 1.3 FAMILY PLACES, v2 LE 1.8 FAMILY SEASONS, v1 LE 2.2 FAMILY WALK 1, v3 LE 4.4 FAMILY WALK, v2	Monthly co-designs: make sense of familial knowledges and practices emerging in family tools	Core research team 2 school design teams: Creekside and Parkview

APPENDIX 4B: Learning Engagement 1.3 Learning Across Places, Version 1

Dear Classroom Family,

In our classroom we are exploring all of the different places where we learn and grow and the human and natural stories of those places! We would like to learn more about the different places your family goes to learn, and your stories with those places. What do you know and wonder about these places that we can learn about in our classroom?

On page 1, please write, draw, or glue pictures of the different places that are important for learning and tell us a bit about what you learn in these places.

On page 2, students will interview you or a family member about your family stories. You can write or record this interview!

On page 3, we have the different "time scales" that students will be learning about. As a family, think about what you know about the history of this place and what questions you would like to know more about. It is okay to leave some spaces blank.

Please return this sheet by _____

What you will need

- Pencil/pen
- Pages 1, 2, & 3 of the Family Sharing Tool

Optional Supplies

- Coloring supplies
- Photographs
- Glue/tape

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APPENDIX 4B: LE 1.3 LEARNING ACROSS PLACES FAMILY KNOWLEDGE & PRACTICE TOOL, V1

Names_____ Date_____

What is a place that is important to your family? _____

Draw or paste a picture of this place.	**Why is this place important to your family?** _____ _____ _____
	What are you curious about this place? _____ _____ _____
	What more do you want to learn about this place? _____ _____ _____

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APPENDIX 4B: LE 1.3 LEARNING ACROSS PLACES FAMILY KNOWLEDGE & PRACTICE TOOL, V1

Names_____ Date_____

How did your family come to be here?

How do you feel when you are in this place? Has this place changed since you were last here?

Who else do you share this place with?

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Overview: There are many *temporal scales* (time scales) that make a place what is today, and what it could be in the future. Histories span across land, plants, animals, and communities over time. Thinking across many scales helps us understand human and natural systems more deeply.

Time Frame	What do we know now?	What questions or wonderings do we want to know more about?
Geologic Time Land and ocean processes, mountain formation, glaciation, etc.		
Plant and Animal Time Plants and animals of the area, species extinctions or adaptations		
Indigenous People's Time Recognizing First Peoples and their histories and current relationships to place		
Recent History 20+ years ago, major events, changes to land, human developments		
Current History Now to 20 years ago, our current relationships to place		
Future Possibilities what are possible stories for this place? How could this place be in the future?		

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APPENDIX 4C: Learning Engagement 1.3 Learning Across Places, Version 2

Greetings Classroom Family!

In our classroom we are exploring all of the different *places* where we learn and grow, including the human and other creatures' stories of those places! We would like to learn more about the different places your family goes to learn, and your stories that are tied to those places. What do you know and wonder about related to these places? We want to know this so that we can learn about some of the places you name and the wonderings you voice.

INSTRUCTIONS

On page 2 of this packet, please write, draw, and/or glue pictures of a place that is important to your family, and tell us a bit about what you learn in this place, what you do in this place, and why this place is important to you and your family.

On page 3 of this packet, your child/children will interview you or a family member about your family stories. You can write or otherwise record this interview.

On page 4, there is a chart that lists different "time scales" that students are starting to learn about. As a family, think about what you know about the history of the place that is important to you (see page 1). Write what questions you have about this place along the different dimensions of time. It is okay to leave some spaces blank.

Please return this activity sheet by_____

What you will need

- Pencil/pen
- Pages 1, 2, & 3 of the Family Sharing Tool

Optional Supplies

Coloring supplies
- Photographs
- Glue/tap

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APPENDIX 4C: LE 1.3 LEARNING ACROSS PLACES FAMILY KNOWLEDGE & PRACTICE TOOL, V2

Who was involved in this discussion? :_____

When did you have this discussion? _____

What is a place that is important to your family?_____
Go on a walk in this place if the place is local and if it is possible to go for a walk there.

Draw or paste a picture of this place.	**Why is this place important to your family?** _____ _____ _____
	What are you curious to learn more about in this place? _____ _____ _____
	What does your family do in this place? _____ _____ _____

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Who was involved in this interview?:_____

When did this interview take place?:_____

FAMILY INTERVIEW

How did your family come to be here?
How do you feel when you are in this place? Has this place changed since you were last here?
Who and what else do you share this place with?

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Overview: There are many *temporal scales* (time scales) that make a place what is today, and what it could be in the future. Histories span across land, plants, animals, and communities over time. Thinking across many scales helps us understand human and natural systems more deeply. There are no right or wrong answers! **Fill out as much of the chart as you want related to the important and meaningful place you have described on the pages above.** The information you write in this chart will help us in the classroom to deepen our classroom wonderings, questions, and investigations about place.

Time Scales	What do we know now about our place related to each of these time scales?	What questions or wonderings do we have about our place related to each of these time scales?
Geologic Time: Land and ocean processes, mountain formation, glaciation, etc.		
Plant and Animal Time: Plants and animals of the area, species extinctions or adaptations		
Indigenous Peoples' Time: Recognizing First Peoples and their histories and current relationships to place		
Nation State Time: How the development of nations over time have shaped and impacted places		
Living Ethical Responsibilities and Possibilities Time: What's possible for places?		

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Appendix 4D: Learning Engagement 2.4 Wondering Walk 1, Version 1

SPRING WONDER WALK 1

WHAT WE'RE DOING: GOING ON A WALK WITH YOU!

There is a lot to be learned by just going outside and noticing what's happening around you. In this activity, your family will go for a walk in your neighborhood, local park, or maybe even the school grounds. The goal is to notice the amazing and exciting things growing and happening in our own communities and connect them to what students are doing in their classrooms.

We are studying about seasons and how they shape what we notice on our walks. As you go for your walk, think about how what you do as a family or community changes as the seasons change.

MATERIALS:

- Field Science Family Wonder Walk 1 Tool
- Pencil or other writing tool
- Clipboard or hard surface for drawing while outside

ACTIVITY:

- Gather your Field Science Wonder Walk 1 Tool, a clipboard or hard surface, and a pencil.
- Go for a walk! You can walk around your neighborhood, a local park, near the school or on school grounds, or somewhere else nearby.
- Outside: What do you notice? What are some things that you are observing? Pick one noticing that really stands out to you and your family. Draw a picture of this.

HOW THIS CONNECTS TO THE CLASSROOM:

- Each student will share their wondering from the family walk. As a class, students will sort ideas and themes that emerge from all of these wonderings.
- These themes will be used in the next activity in class, Field Science Classroom Wonder Walk 2. Eventually, these wonderings will lead to questions, and later, field science investigations!

WHAT'S PHENOLOGY?

*Phenology is the study of **seasonal impacts on plant and animal life cycles**. By investigating seasonal changes, families and students can make observations, collect data, and apply their learning to the local environment.*

FAMILY TIP

- Your child is learning about phenology in class. Ask them to tell you a seasonal story they are learning or do you have a story to share with them?

- Kids notice with their whole bodies. When on your walk ask them questions about what they are seeing, smelling, feeling, and help them know what they can or cannot touch and taste!

APPENDIX 4D: LE 2.4 WONDERING WALK 1 FAMILY KNOWLEDGE & PRACTICE TOOL, V1

SPRING WONDER WALK 1

Student Name & Who Went on the Walk with You?

_____

Today's Date_____

The Weather Today is

_____

Outside: As you take your walk, if you notice something that you think is interesting or you wonder about, pause your walk and draw it here!

FAMILY TIP:

Your child may ***ask you questions*** you do not know the answer to, such as the name of a plant or animal, or why things are happening the way they do.

This is a ***good sign*** your child is interested and engaged! And it is a good opportunity to wonder about something together and talk about how you might find out the answers. Scientists study things they do not already know - remind your child that ***by asking questions they are doing science***!

These wonderings will be shared with the classroom and may become part of the investigation that children do!

Inside: Looking at your picture and thinking back to our walk, draw or write your thoughts to the questions below. You can use the back of this page or additional paper if you need. There are no right or wrong answers.

1. We noticed...

2. We wondered...

3. The season we are in is _____

How might what we noticed be connected to the season?

Does your family have a story or practice related to this season that you would like to share?

APPENDIX 4D: LE 2.4 WONDERING WALK 1 FAMILY KNOWLEDGE & PRACTICE TOOL, V1

SPRING WONDER WALK 1

Extra drawing and writing space

Appendix 4E: Learning Engagement 2.4 Wondering Walk 1, Version 2

Taking a Wondering Walk Together

Seasons greetings classroom family!

In our classroom we took a walk to get excited about what we might want to learn together. As we walked we drew a picture of something we wondered about!

We would like to learn more about what your family notices and wonders about in a place that is important to you.

As you go on a short walk in an important outdoor place, draw a picture of something that stands out and write down what it is you noticed (We noticed) and what you want to know more about (We Wondered).

Please return this activity sheet by _____.

What you will need

- Pencil/pen
- Pages 2 Family Knowledge Sharing Activity
- 10-15 minutes

Optional Supplies

- Coloring supplies
- Photographs

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LE.2.4 FAMILY SHARING

Taking a Wondering Walk Together

Names:_____Date _____

Question: What do we notice and wonder about in our homes and neighborhoods?

Draw or paste your picture here	We noticed _____ _____ _____ We wondered _____ _____ _____ _____

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LE2.4 FAMILY SHARING

Question: What do we notice and wonder about in our homes and neighborhoods?

Extra writing/drawing space

Learning in Places

APPENDIX 4F: Learning Engagement 2.4 Wondering Walk 1, Version 3

Family Wondering Walk

Seasons greetings classroom family!

We took a walk at our school to get excited about what we want to learn together. As we walked we drew a picture of something we wondered about!

We want to learn more about what the families in our class notice and wonder about in the places that are important to you. You might remember doing a similar activity where you visited or talked about a place that is important to your family. If so, you could walk to a different place this time, or revisit the same place. You might notice something different than last time!

As you go on a short walk together, draw a picture of something that stands out and write down what you noticed (We noticed) and what you want to know more about (We Wondered). We'll add the wonderings from the family walks to the wonderings our class collected at school.

Please return this activity sheet by _____.

What you will need

Pencil/pen

This packet

10-15 minutes

Optional Supplies

Coloring supplies

Photographs

Some places you can walk:

Around the block in your neighborhood

In a park close to your house

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APPENDIX 4F: LE 2.4 WONDERING WALK 1 FAMILY KNOWLEDGE & PRACTICE TOOL, V3

Taking A Walk Together

Family Names:_____ Date: _____

The season is: _____

The place we walked is: _____

Draw or write what you notice that is interesting to you in the space below.	We noticed: _____ _____ _____ _____
	We wonder: _____ _____ _____ _____

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APPENDIX 4G: LE 4.4 WONDERING WALK 1 FAMILY KNOWLEDGE & PRACTICE TOOL, V1

APPENDIX 4G: Learning Engagement 4.4 Wondering Walk 2, Version 1

FAMILY SHARING

Wondering Walk #2: Seeing Phenomena in Places

Names:_____Date _____

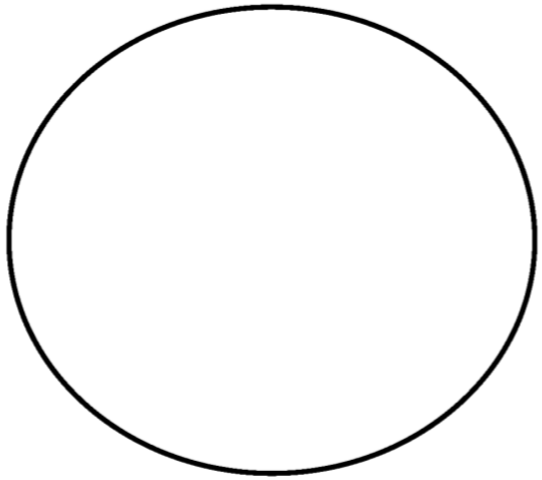
The phenomena my family is observing is _____ Place _____

Above

Draw your picture here

Around

Below



Weather

Temperature

APPENDIX 4G: LE 4.4 WONDERING WALK 1 FAMILY KNOWLEDGE & PRACTICE TOOL, V1

FAMILY SHARING

What are some interesting things you noticed or wondered about on your walk?

Extra writing/drawing space

Learning in Places

APPENDIX 4H: Learning Engagement 4.4 Wondering Walk 2, Version 2

Names:_____ Date _____

The relationship phenomenon my family is observing is

_____with_____

Place _____ Weather:_____

Temperature:_____

Draw what you observe about your relationship phenomenon today.

What is above, around, and below?

↑above

around ←

→

↓ below

We wonder…

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APPENDIX 4I: CODING SCHEME FOR SOCIO-ECOLOGICAL SENSEMAKING AND DECISION-MAKING

Appendix 4I: Coding Scheme For Socio-Ecological Sensemaking And Decision-Making Dimensions

DIMENSION	HEAD CODE	SUB CODE	EXAMPLE/DEFINITION
SPECIES, KINDS, AND BEHAVIORS/CHARACTERISTICS	Species (Human and More-than-Human)	Amphibian	e.g., frog, salamander
		Animal - general	use of the generic term "animal"
		Bird	including specific names (e.g., seagull, robbin) and generic term "bird"
		Fish	including specific names (e.g., salmon) and generic term "fish"
		Fungus/lichen	e.g., mushroom
		Humans	including specific names of family members
		Insect/Arachnid/Bug, etc	including specific names (e.g., ladybug, slug) as well as generic terms such as "bug," "spider"
		Pet	including specific names of pets and generic "pets"
		Plant	any plant or plant part (branch, leaves, etc)
		Prehistoric	e.g., dinosaurs
		Reptile	e.g., snake, turtle
		Sea invertebrate	e.g., star fish, sea urchin
	More-than-Human Kinds	Cloud	
		Rock	
		Soil/ dirt	
		Sun	
		Weather	written description (noticings/wonderings) of weather only; does not include temp/weather icons on LE 2.4 or 4.4
		Water	e.g., rain, tides, puddle, ocean, glacier
	Behaviors/ Characteristics	Adaptation/ evolution	e.g., how did the dinosaurs get extinct?; how did dinosaurs become birds?
		Animal/ kind specific	e.g., fish swimming, bird nesting/flying, vines growing, etc
		Eating/ drinking	e.g, what do ducks eat?
		Life cycle/ rearing/growth	e.g., mama bird feeding her baby birds, how long does it take for the tree to grow?
		Visual characteristics	description/question of how something looks (structure or function)

APPENDIX 4I: CODING SCHEME FOR SOCIO-ECOLOGICAL SENSEMAKING AND DECISION-MAKING

DIMENSION	HEAD CODE	SUB CODE	EXAMPLE/DEFINITION
RELATIONSHIPS	Base Relationships	Animal-animal	e.g., mama bird feeding her baby birds, bird eating worms
		Animal-kind	e.g., worm in dirt, animal drinking water
		Animal-place	e.g., who lives in this hole, where do bugs live in winter?
		Animal - plant	e.g., squirrels eating nuts, bird hiding in a tree
		Plant-plant	e.g., moss growing on tree
		Plant-place	e.g., why is this tree growing here?
		Plant-kind	e.g., plants need water and sunlight
		Kind-kind	e.g., rocks in water, puddles in dirt
		Kind-place	e.g., why are there rocks here?
		Human-animal	e.g., humans feeding ducks
		Human-human	e.g., we go biking with our friends; we celebrate birthdays
		Human-kind	e.g., going swimming in water, using rocks to make a bridge
		Human-plant	e.g., harvesting fruit from garden; measuring plant as it grows
		Human-place	e.g., family important place, migration/diaspora
	Web Causal Relationship (not in analysis)	3 + relationships	among 3 or more organisms/kinds that follow a web-like relationship (e.g., eagles, bears, and humans eat salmon, and trees absorb nitrogen from salmon die-off)
PLACES, LANDS, & WATERS	Kinds of Places	Waters	body of water e.g., ocean, pond, glacier,
		Backyard/ neighborhood	human-centered place local to home e.g., backyard, neighbor's yard, "in the neighborhood" "around the block"
		Building/built place	e.g., home/house, sidewalk, construction area, playground, restaurant
		Other nation	named/drawn other nation-state, or city in other nation e.g., Cuba, Canada, Vancouver (CA), drawing of national flag
		Other State in the U.S.	state or city outside of the one where implementation took place

APPENDIX 4I: CODING SCHEME FOR SOCIO-ECOLOGICAL SENSEMAKING AND DECISION-MAKING

DIMENSION	HEAD CODE	SUB CODE	EXAMPLE/DEFINITION
PLACES, LANDS, & WATERS CONT.	Ecosystems	Beach	
		Forest/ woods	
		Island	
		Mountain	
		Wetlands	
		Park/ nature preserve	named local park, city park, state park, national park e.g., Yellowstone Nat'l park, "Parkview Park" *some park names in family tool responses were Googled to see if they were local (within a day's drive)
		Desert	
		Prairie	
	Secondary Codes: Familial Relationships to Place Coded LE 1.3 only	Vacation place	family describes this as a vacation place or get-away place e.g., family cabin, camping spot
		Former homeland	family describes this as a place they have lived before
		Current homeland	family describes a place as important because it is where they live "we live here," "it's where my family lives"
		Natural place	family describes this place as somewhere to reconnect with nature, or learn more about nature e.g., leaving an urban place, there's fewer people
	Tertiary Codes: Scale of Place Coded across all primary places, lands, and waters codes	Local	within approximately 1 day's drive from city where implementation in this study took place
		Global	further than approximately 1 day's drive from city where implementation in this study took place
THINKING ACROSS SCALES	Temporal	Geologic time	land and ocean processes, mountain formation, glaciation, etc e.g., glaciers are melting
		Plant & animal time	plants and animals of the area, species extinctions or adaptations e.g., where did dinosaurs go?

APPENDIX 4I: CODING SCHEME FOR SOCIO-ECOLOGICAL SENSEMAKING AND DECISION-MAKING

DIMENSION	HEAD CODE	SUB CODE	EXAMPLE/DEFINITION
THINKING ACROSS SCALES CONT.	Temporal Cont.	Indigenous peoples' time	recognizing First Peoples' and their histories and current relationships to this place e.g., naming Indigenous sovereign nations and peoples of area, describing relationships, actions, and histories
		Recent/current time	now and 20+ years ago, major events, changes to land, human developments, current relationships to place e.g., skyscrapers have been built
		Nation-state time	how the development of nations over time have shaped and impacted places e.g., "now Trump is president"
		Ethical responsibilities /possibilities time	what's possible for places e.g., pollute less
	Drawing Perspective	View from above	drawing is as if artist is looking down on subject/object
		View straight on	drawing is as if artist is looking straight ahead or at eye level
		View from below	drawing is as if artist is looking up from below the subject/object
	Drawing Distance	Below ground	drawing includes a perspective under the ground
		Close up	drawing is "zoomed in" on subject/object and appears intended to draw the view into noticing something closely
		Mid-view	drawing encompasses a full field-of-vision
		Distance	drawing is "zoomed out" on the subject/object, including panorama views or map-like views
HUMAN DECISION-MAKING	Nature-Culture Human Practices	Nature foregrounded	activity where the purpose is to be in/with nature e.g., camping, hiking, watching sunset
		Nature backgrounded	activity where nature is present, but the purpose is not to be in/with nature e.g., celebrating birthday at a park; hanging out with friends on a playground; being in a hot tub
		Nature absent	activity where nature is not present e.g., shopping at a local store, going to religious center, playing indoor games with family
		Unknown	activity where it is unclear what the nature-culture intent is e.g., we like to go to the park as a family; we have a cabin in the woods

APPENDIX 4I: CODING SCHEME FOR SOCIO-ECOLOGICAL SENSEMAKING AND DECISION-MAKING

DIMENSION	HEAD CODE	SUB CODE	EXAMPLE/DEFINITION
HUMAN D-M CONT.	Nature-Culture Human Practices cont.	Helping/hurting	we can pollute less; we can help the salmon
		No nature-culture practice identified	No familial practices or nature-culture practices named in tool e.g., LE 2.4 and 4.4 did not ask families to say what they do in the place