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Publication Date

2022

Peer reviewed|Thesis/dissertation

Co-designing an Indigenous Making Learning Ecology Centered in Wellbeing

By

Elena Cristina Durán López

A dissertation submitted in partial satisfaction of the
requirements for the degree of

Doctor of Philosophy

in

Science and Mathematics Education

in the

Graduate Division

of the

University of California, Berkeley

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Professor Alice M. Agogino, Co-chair

Professor Kris Gutierrez, Co-chair

Professor Michelle Hoda Wilkerson

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Summer 2022

Co-designing an Indigenous Making Learning Ecology Centered in Wellbeing

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Abstract

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Elena Cristina Durán López

Doctor of Philosophy in Science and Mathematics Education

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As maker education gained widespread traction, scholars reacted to a lack of criticality and a lack of attention to issues of equity and diversity in some mainstream implementations and approaches (Barajas-López & Bang, 2018a; Buechley, 2013; Vossoughi, Hooper, & Escudé, 2016). Inspired by this scholarship, recent decades have seen the growth of work on culturally-based STEM education in Indigenous communities, which sheds light on the richness and complexity of Indigenous cosmovisions, worldviews, and systems of knowledge (Bang & Marin, 2015; Bang & Medin, 2010; Bang, Medin, Washinawatok, & Chapman, 2010; Cajete, 2000; Eglash, 2007; Elk, 2016; Medin & Bang, 2014b).

Building on this work, this dissertation presents a case study of a three-year-long co-design project of a makerspace between the northern Californian Pinoleville Pomo Nation (PPN) and a team from the University of California, Berkeley (UCB). In particular, this dissertation works to:

- a. address a gap in the literature regarding the specifics of co-designing an Indigenous making learning ecology centered in wellbeing, and
- b. contribute to the co-design literature by exploring how non-dominant worldviews can be filtered by dominant perspectives.

After situating the dissertation in the literature, in history, and in the relevant frameworks (Chapter 1) and addressing my own positionality in relation to the dissertation (Chapter 2), I move to address (a) and (b) over a series of four analytical chapters. In the first of these, Chapter 3, I describe the co-design process and its development over time, discussing the makerspace project in two complementary ways: quantitatively, through an analysis of the nature and composition (in terms of Native vs. non-Native representation) of exchanges between the PPN and the UCB teams; and qualitatively, through summaries that emphasize co-design events with community participation, and discuss the project's changing goals, priorities, and practices.

In the second empirical chapter, Chapter 4, I subject the co-design events identified in Chapter 3 to further self-reflective examination. In particular, I show how Native worldviews might get unintentionally filtered out by novice non-Indigenous designers. Building from a high-resolution timeline developed in Chapter 3, I identify dissonant, critical incidents (Miles & Huberman, 1994a)

and examine shifts in my conceptualization of the makerspace project, showing how these might have been linked to the filtering of community worldviews.

The third empirical chapter, Chapter 5, responds to the shifts identified in Chapter 4 by seeking to better understand the community's perspectives around wellbeing, STE(A)M fields, and their intersections. The findings in this chapter are based on 21 semi-structured interviews with community members that were transcribed and then cleaned, coded, and analyzed in MaxQDA using a dual-pass coding technique (Saldaña, 2021) structured as follows: first, transcripts were coded along the major themes derived from the interview guide; second, coded segments from the first pass were analyzed for patterns across participants.

The last of the empirical chapters, Chapter 6, exemplifies and synthesizes the previous findings through a telling case (Mitchell, 1984) of one culture keeper's description of her basketmaking practice. Here, I present an analytical exercise about the culture keeper's basket making practice intended to serve as a microcosm for the themes, shifts, and worldviews elaborated in the previous empirical chapters. In this chapter I seek to illustrate how different lenses, as partial proxies for particular worldviews, can "filter the intelligibility of the practices of historically non-dominant communities through normative onto-epistemologies" (Bang & Vossoughi, 2016, p. 181).

Bringing these six chapters together, the dissertation's key findings can be broken into the following themes:

- *Community participation and representation in co-design.* This dissertation underscores the importance of differentiating between general community participation and representative regular participation. The former is focused on the core design team interacting with the broader community whenever possible. The latter has to do with key community members being an integral part of the design/research team and therefore engaging in everyday kinds of design meetings. Both types of participation are at the core of promoting transformative agency not only as an outcome of the project that is being designed but also as a result of participating in the design process. However, community participation alone may not be sufficient to ensure that Indigenous worldviews are consistently represented in the design process, especially when novice non-Indigenous designers have a predominant role in guiding that process. The development of design sensitivities and commitments that are key to acknowledging and genuinely engaging with unfamiliar worldviews can be promoted through targeted education and reflection on the part of non-Native researchers — work that can avoid placing additional burden on the time and energy of Indigenous community members.
- *Community perspectives on wellbeing and STE(A)M.* According to community members, wellbeing is not only about balance, spirituality, and wholeness, but also about fostering cultural connections and identity, as well as about healing from historical trauma. Community members' perceptions of STE(A)M were multifaceted. I conclude that, by both entangling and juxtaposing the topics of Indigenous wellbeing and STE(A)M, we can at once honor connections to valuable ancestral wisdom and practices, and acknowledge the ways in which these two worlds are distinct and irreducible.
- *Community perspectives on Making.* The exercise undertaken in Chapter 6 emphasizes the relational nature of Indigenous Making practices, which elevate relations with people, the land and environment, the cosmos, and ideas; secondly, in a broader sense, it speaks to the concerns that prompted this dissertation, namely the potential role of a non-Indigenous novice researcher in either filtering out or facilitating participants' perspectives.

Pulling these themes together allows us to return to a key question on which this dissertation sheds

light: What are the best practices when non-Indigenous novice designers work with Indigenous communities to co-design a transformative learning space? This dissertation suggests several avenues, including but not limited to self-reflection and learning; providing appropriate infrastructures for interactions between researchers and community members; paying attention to issues around the division of labor and connection to culture keepers; monitoring the amount and nature of the interactions between participants; and openness to non-dominant worldviews. Another important consideration is that the solutions need to be local: We need new and imaginative ecologies and possibilities for both researchers and Native communities around culture, wellbeing, and STE(A)M. These imaginative possibilities should go beyond the canonical formulations of makerspaces or mere integration of new materials and processes. In approaching co-design processes, we should seek to fulfill the multifaceted, nuanced, and varied desires and needs of Native communities – communities which often find themselves trying to maintain a complex equilibrium between survival and resurgence that hinges on, among other things, healing from historical trauma, cultural preservation, and diverse generational needs.

Dedication

A Michita

A Mercedes Maita, mi segunda madre, una mujer indígena amable, cariñosa y generosa, que me ha enseñado lecciones que permanecerán en mi corazón a lo largo de los años. Cuando era niña, mi mamá le pidió que me enseñara su idioma nativo, el quichua. Sin embargo, nunca lo hizo, porque cuando niña, castigada en la escuela cada vez que lo usaba, se avergonzaba de su idioma. Michita, como muchos Indígenas, creció sintiendo que era una ciudadana de segunda o tercera clase, que hablaba un idioma ‘equivocado’ y que, probablemente, olvidar quién era y de dónde venía era la única manera correcta de existir. Que nunca se olvide su dolor y el dolor de tantas otras generaciones que vivieron antes que ella.

Espero que esta disertación sea un pequeño aporte para que ningún indígena, en el Ecuador o en cualquier otro lugar, se avergüence de sus orígenes, de su cultura y de su cosmovisión. Michita, esta disertación es lo menos que podría haber hecho como una pequeña muestra de mi amor por todos los años de tu cuidado, sabiduría e inspiración. Espero que, algún día, nuestra manera de vivir sea celebrando, y no reprimiendo, todas las formas de vivir, ver, y sentir el mundo.

A Paco y Colomba

A mi papá quien supo desde mi nacimiento que estaba destinada a ser una científica. Desde que tengo memoria fui su “pequeña científica,” y cada vez que lo escuchaba llamarme así, mi corazón se llenaba de amor. Mi papá me contagió su pasión por el mundo de las ideas, los números, y los misterios de la física. Nunca te olvides.

$$\bigoplus \left[{}^{-\infty} \right) \text{---} ({}^{+\infty} \left. \right] ^n$$

A mi mamá, doctora en medicina, para quien el mundo más importante no es el del laboratorio sino el de la espiritualidad y la naturaleza. Mi mamá me ha mostrado el otro lado: el de lo imponderable, lo milagroso, lo espiritual, lo armónico.

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Preface

Mi papá supo desde mi nacimiento que estaba destinada a ser una científica. Desde que tengo memoria fui su “pequeña científica”, y cada vez que lo escuchaba llamarme así, mi corazón se llenaba de amor. Crecí viendo a mi padre, un químico y emprendedor, hacer cientos de experimentos. Como uno podría esperar, sólo algunos funcionaban. Sorprendentemente, él siempre estaba ahí, perseverando, intentándolo de nuevo y diciéndome, al estilo de Edison, que no había fallado, que solo había descubierto muchas formas en las que cierto experimento no funcionaba. Para mi mamá, doctora en medicina, el mundo más importante no es el del laboratorio sino el de la espiritualidad y la naturaleza. En muchas ocasiones me llamaba la atención para que apreciara como algunas plantas crecían en las condiciones más adversas. Siempre con el más profundo respeto y admiración hacia la madre naturaleza me muestra brotes verdes en la mitad de selvas de cemento o en troncos aparentemente muertos. Mi mamá me ha mostrado el otro lado: el de lo imponderable, lo milagroso, lo espiritual, lo armónico. Esta tesis, no por casualidad, mira tanto hacia lo de afuera, como me enseñaba mi padre, como hacia lo de adentro, como mi madre me sigue enseñando.

Cuenta la leyenda que cuando yo era pequeña mis padres fueron a un musical y se enamoraron de una de las canciones de la obra: “El Sueño Imposible”. Mis hermanas y yo crecimos escuchando esa canción, cuya letra habla del ideal quijotesco de soñar lo imposible, y superar obstáculos insalvables. Una de esas tardes en nuestra casa en Cuenca, comencé a imaginar mis propios sueños.

Mi sueño imposible como adolescente era desafiar el agudo discurso machista y clasista de la sociedad que me rodeaba. En ese entonces de manera ingenua decidí que no me casaría, que no tendría hijos(as) y que me dedicaría por completo a ser ‘exitosa’. Me autoimpuse una disciplina draconiana, pasé innumerables noches en vela, me perdí reuniones familiares, rechacé invitaciones sociales de amigas(os) y, en una promoción de ingeniería con innumerables hombres y poquísimas mujeres, me gradué en primer lugar. Un sueño de juventud hecho realidad.

Pero otro sueño llegó algunos años después: realizar un doctorado en la Universidad de California en Berkeley. En ese entonces pensaba que el doctorado sería otro de esos sueños, logrado con mi inquebrantable disciplina, y que daría como resultado una tesis científicamente impecable. Sin embargo, la vida pronto me enseñó que lo importante no era la disciplina, el rendimiento, la previsibilidad, la lucha quijotesca contra los obstáculos. Más bien era una cierta indisciplina, un placer difuso de no saber a dónde iba, un nuevo perderme en ideas, bibliotecas y conversaciones con mis amistades, un irresistible estar de acuerdo y en desacuerdo con los demás. Descubrí teorías que extrañamente no iluminaban un camino cierto y sólido, sino que creaban nebulosas nuevas y multiformes para explorar y corazonar.

Al final, mi trayectoria en UC Berkeley no ha sido ejemplar, heroica ni impecable. No fui la mejor estudiante del programa, ni un modelo a seguir. Podría decirse que mi tesis tiene más preguntas que respuestas. En incontables momentos sentí que estaba decepcionando a mi familia, amigas(os), y a mí misma. Pero en la última etapa de este viaje de ocho años, me he dado cuenta de que la gente que me quiere no esperaba que, como una atleta invicta, cruzara gloriosamente la línea de meta. Cuando mi padre me llamaba a su laboratorio para contarme, con regocijo, que uno de los cientos de experimentos había funcionado, quizá me hablaba más del placer de poder hacer experimentos que de que salieran bien. Y cuando mi madre me llamaba para que viera las pequeñas plantas que brotaban en los lugares más inhóspitos, tal vez intentaba enseñarme que los pequeños milagros eran tan importantes como los logros quijotescos.

En definitiva, quizá no esperaban una vuelta olímpica gloriosa. Probablemente sólo querían saber que caminaría, sin prisa, por los caminos torcidos de la vida, admirando a las plantas que insisten en existir y apreciando los inventos que se ríen de su impracticabilidad. Quizás querían enseñarme que la vida es una caminata imperfecta, caótica, y que lo que realmente importa es el significado que uno le da al viaje. Tal vez mi padre realmente quería enseñarme que mi laboratorio sería el mundo, este mundo, lleno de peligros, de miedo, de dolor, pero espléndidamente ebullente de amor, de belleza y de música. Y mi madre, de hecho, quería decir que el mundo nos “brota” milagrosamente de la nada para que podamos rehacerlo y rehacernos.

Y en estos momentos finales, mi sueño, en realidad imposible, es tener un minuto más con mi padre, una historia más de un experimento, un abrazo más con ese amor incondicional que derrite los huesos y el corazón. Daría cualquier cosa por ese minuto extra, el que me llega a veces en sueños inquietantemente reales, cuando mi padre, con sus ojos verdes, me dice con amor, alegría y esperanza, que soy, y para siempre seré, su pequeña científica.

Acknowledgements

A mis hermanas, María Elisa, y Juana. María Elisa, gracias por tu amor, por ser un ejemplo a seguir, y por enseñarme las maravillas del mundo de las manualidades y creatividad. Juana, gracias por tu ternura y por mostrarme que relativizar los problemas de la vida, y aceptar los contratiempos como parte de nuestra existencia, es una muy buena filosofía de vida. Hakuna matata.

A mi abuelita, gracias por compartir tu dulzura centenaria conmigo.

A mis tías, tíos, y primas, quienes cada vez que nos reunimos alrededor de la misma mesa, comiendo, hablando y riéndonos de las aventuras de tiempos pasados me demuestran que nos necesitamos los unos a los otros más de lo que sabemos.

A Paulina, mi hermana cósmica, gracias por hacer de este viaje de ocho años una lección de amistad, atardeceres, paisajes, y de estar ahí la una para la otra. Gracias por ayudarme a crecer, reírme, y disfrutar de la vida.

Anna, who was there from the start, always. Thank you for continuously and generously showing me that there are always new ways to think about things, and that good questions are usually better than answers.

Leah, thank you for being such an amazing friend, for your above-and-beyond support, for repeatedly catching me while I was falling, and for being the best and most fun project partner ever!

Adela, Maribel, Javier, Pablo, my wonderful friends from Berkeley. Natalia, María Fernanda, Diego G., Paúl, and Diego M., mis amigos de Cuenca, gracias por ser parte de mi vida.

César, mi querido colifato, gracias por inspirarme por más de veinte años con tu corazón multicolor y por contagiarme tu pasión por la vida.

Zhao, John, and Ilena, who even while not knowing me well, adopted and loved me like family in Ukiah.

Greater Ukiah Native American community, who allowed me to work with them and who have taught me new ways of being, seeing, and making in this world.

To Erin and Michelle, for their patience, their care, time, amazing suggestions, and ideas; for deeply engaging with my work, and for being there for me even in the hardest hours. Thank you, Erin, for organizing such a wonderful homage to my father! Thanks, Michelle, for being part of it.

To Kris and Alice, for showing me the way, with love, grace, and generosity; for putting up with me in my moments of doubt; for creating research environments that foster brilliance, new ideas, and community; and for giving me the freedom to succeed and to fail.

Ranjini, my wonderful URAP student, who helped me to analyze the data and kept me motivated to work every week.

And last but not least, to Paulo, for enmeshing me in this whirlwind of love, chaos, wonder and blind hope that is our life.

Chapter 1

Introduction

For decades, Science, Technology, Engineering, and Mathematics (STEM) education researchers and educators have been devoted to finding ways to bring powerful ideas, literacies, and expressive tools to children (Blikstein, 2013; Papert, 1980). In the 2000s and 2010s, advances in digital fabrication and decreases in the cost of digital technologies allowed for the popularization of *making* as an educational practice, one that had strong ties to STEM fields. This historical context provided unprecedented opportunities to pair long-advocated ideas around STEM interest-driven curricula and project-based pedagogies with low-cost technological tools. Learning scientists¹ saw in this combination a powerful way to engage learners in personally meaningful investigations of the socio-material world (Blikstein, 2018; Halverson & Sheridan, 2014; L. Martin, 2015), democratize inventive practices previously available only to a few (Blikstein, 2013), and increase participation in STEM fields (Brahms, 2014; L. Martin, 2015). These benefits did not go unnoticed by policymakers, who frequently position maker education as an auspicious platform for STEM education reform and as an avenue to the U.S.’ future economic success (Brahms, 2014).

As maker education gained widespread traction, scholars reacted to a lack of criticality and a lack of attention to issues of equity and diversity in some mainstream implementations and approaches. For example, Buechley (2013) strongly criticized the Maker Education Initiative (currently Maker Ed), a non-profit organization associated with Make: Magazine and the Maker Faire and at that time the most visible organization within the Maker Movement. She pushed back on the Maker Education Initiative’s heavily-advertised promise to “reach every child” without acknowledging the problematic tunnel vision that the organization had inherited from the culture of the Maker Movement itself.² She pointed out, for example, that 85% of Make: Magazine’s covers featured white boys and male-inspired projects such as rockets and robots, and paid little to no attention to maker projects inspired by non-dominant cultures and communities. Buechley’s critique was a turning point in maker education, and many other scholars soon followed her example.

Concerning the dynamics between making and power relations, other scholars have exposed the consequential implications of normalizing and popularizing homogenous notions of making (Barajas-López & Bang, 2018a). These authors challenge the narrow and monolithic definition of making by historicizing it as an ancestral cultural practice—*Making*³—that allows for multiple perspectives both on its aims and on the relationships and identities it affords (Barajas-López & Bang, 2018a; Buechley, 2013; Vossoughi et al., 2016). In other words, resituating Making as a human practice

¹ Learning sciences (LS) is an interdisciplinary field that is concerned with understanding processes of learning, particularly as learning unfolds in complex socio-material, ecological, and technical contexts. It also engages in the design and implementation of learning innovations, and the improvement of instructional methodologies and environments.

² This movement was born as a result of the prosperity of the Make: Magazine and the Maker Faire (both efforts directed by the O’Reilly Media corporation). In 2004, the corporation named the “Maker Movement” with the launch of Make: magazine, and in 2005, Maker Faire. In 2012, O’Reilly spun out Make: into a separate venture-backed company, Make Media, headed up by former O’Reilly executive and Make: founder Dale Dougherty (O’Reilly Media, n.d.).

³ Throughout this document I will consistently use *making* to denote the branded, narrow definition inherited from the Maker Movement, while *Making* will refer to the ancestral cultural practice.

could support diverse cultures and worldviews.

Inspired by this scholarship, recent decades have seen the growth of work on culturally-based STEM education in Indigenous communities. Such research seeks to cultivate ways of knowing, being, and doing that enact Indigenous presence, resurgence, and sovereignty in everyday ways (Bang & Marin, 2015; Bang & Medin, 2010; Bang et al., 2010; Cajete, 2000; Eglash, 2007; Elk, 2016; Medin & Bang, 2014b). Besides challenging normative settler-colonial constructions of science, place, and technology, this work also sheds light on the richness and complexity of Indigenous cosmovisions, worldviews, and systems of knowledge.

As issues of systemic inequality and power continue to gain their rightful visibility, participatory design methodologies have become especially relevant for researchers working with non-dominant communities. Despite the existence of insightful and rigorous work on *making* and Indigenous communities (Barajas-López & Bang, 2018a; Searle et al., 2018; Tzou et al., 2019), it is still an underexplored area of research. For example, many of the existing projects use participatory design methodologies (Barajas-López & Bang, 2018a; Searle et al., 2018; Tzou et al., 2019); however, more work is needed to understand the details and challenges of the design process itself, particularly as applied across specific communities and contexts.

This dissertation presents a case study of a three-year-long co-design project between a small Native American tribal nation in northern California, the Pinoleville Pomo Nation (PPN), and a team from the University of California, Berkeley (UCB). The aim of documenting the design trajectory of a culturally sensitive makerspace is to inform and aid other, similar co-design efforts in which novice, non-Indigenous designers are working with Indigenous communities to create transformational learning ecologies anchored in making and wellbeing (Barajas-López & Bang, 2018a). In particular, this dissertation works to:

- a. address a gap in the literature regarding the specifics of co-designing an Indigenous making learning ecology centered in wellbeing, and
- b. contribute to the co-design literature by exploring how non-dominant worldviews can be filtered by dominant perspectives.

The remainder of this introductory chapter gives background on the partnership between the PPN and UC Berkeley as well as the history of the PPN. I then elaborate on the purpose of this dissertation and the research questions that guide it. The subsequent literature review covers the history of making in education, considerations of power and culture in making, and research on Indigenous making as well as summarizing the state of research on co-designing Indigenous makerspaces. Next, I outline the three theoretical frameworks that guide this dissertation and how they inform the design approach undertaken in the makerspace project. Finally, I justify the significance of this dissertation and give a roadmap for the remaining chapters.

Background

The Pinoleville Pomo Nation-UC Berkeley Partnership

The collaboration between the Pinoleville Pomo Nation (PPN), a sovereign Native American tribe from California, and a team from UC Berkeley originated in 2007 when members of the tribe became interested in green homes for its citizens. Ryan Shelby (2013), one of the UCB team members, explained that Dr. David Edmunds—the director of the tribe’s Environmental Protection Agency

(EPA) department at that time—spearheaded the partnership. The PPN government supported his initiative because they felt the tribe “could leverage for support in their endeavors” through Dr. Edmunds’ wife, Dr. Kimberly TallBear, a professor at UC Berkeley (Shelby, 2013). However, some tribal members felt fearful and suspicious about the potential collaboration with an academic institution and non-Native people. In the words of the PPN’s then vice chairperson,

I have family members who attest to the issue of UC Berkeley housing Native American remains. This issue was in the media when Pinoleville Pomo Nation began collaboration efforts with UC Berkeley Engineering Department on the Culturally Informed Sustainable Green Housing. I have family who has strong feelings regarding the remains they want to be returned to the Tribe for proper burial. My relatives have been fighting for their rights against UC Berkeley. When the collaboration began, I felt as if I was betraying my relatives to collaborate with the university. (Shelby, 2013)

Despite this uneasiness, some PPN members met with representatives of the UCB American Indian Graduate Program in March 2008 to discuss a potential collaboration. During this meeting, a PhD student—now Dr. Benjamin Fine—introduced Dr. Edmunds to the work of Prof. Agogino and her students. Through a series of interactions between Prof. Agogino and the PPN’s tribal council, it was jointly agreed that the partnership would revolve around the *design of culturally inspired and sustainable houses* (for more details see Shelby, (2013)). Eventually, two culturally inspired, efficient model homes, featuring natural materials and integrated renewable energy systems, were built in the PPN rancheria. Despite the initial hesitation of some tribal members (Shelby, 2013), a promising long-term relationship was born. Since then, the list of collaborative projects has grown (e.g., designing the PPN’s living culture center (Perez, 2013), modeling energy use in the PPN’s sustainable homes (Lee, 2013), and a life cycle assessment of the homes (Van Lieshout, 2015)).

A second generation of the PPN and UC Berkeley collaboration began in early 2017 after Prof. Agogino and colleagues were awarded an NSF Research Traineeship (NRT) grant⁴ on Innovations in Food, Energy, and Water Systems (Agogino, Kammen, Levine, Potts, & Nelson, 2016). While applying for the grant in 2016, Prof. Agogino contacted the tribal council to inquire whether they would be interested in working together on projects connected to food, energy, and water systems. Consequently, Prof. Agogino invited some of her graduate students, including myself, to join the collaboration. Pierce Gordon, George Moore, and I felt passionate about designing for social justice, were interested in design thinking, and shared a formal background in engineering. We also happened to be non-Native. The remainder of 2017 was devoted to scoping the design partnership.

In 2018, the PPN’s educational director⁵ shared that the PPN was in the process of developing a STEM lab. After some conversation between the PPN and UCB teams, the STEM lab was rethought as a culturally sensitive STEM makerspace. As expected, the design trajectory has since been characterized by minor and major shifts, which are evidenced by several iterations of the name of the educational space: from *culturally sensitive STEM makerspace* (April 2018), to *[]-Space* (December 2018),

⁴ The NSF Research Traineeship (NRT) program is “dedicated to effective training of STEM graduate students in high priority interdisciplinary or convergent research areas” (NSF). This US-based program’s funds are exclusively for U.S. graduate students. Therefore, neither PPN community members nor international students can be supported using these funds.

⁵ This person was actually the Self-Governance Grants Administrator of the tribe and the Pomo Youth College and Career Success Project (PYCCSP) Director. However, she was also the “go to person” for any educational initiative. Thus, for the sake of simplicity I refer to her as the Educational Director throughout the dissertation.

to finally an *Indigenous Making Learning Ecology Centered in Wellbeing* (March 2021). This last iteration of the design project is guided by holistic perspectives around ecological flourishing and Indigenous sovereignty, while remaining situated at the intersection of wellbeing, STE(A)M education, and Making. I created Figure 1.1 to depict the project's location at this intersection.

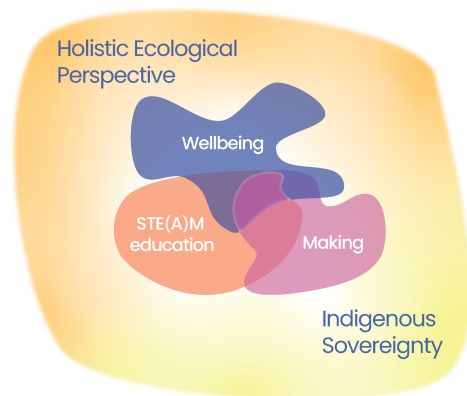


Figure 1.1. Framing of the Indigenous Making Learning Ecology centered in Wellbeing

The Pinoleville Pomo Nation

The Pinoleville Pomo Nation (PPN) is a small federally recognized, self-governing Native American tribe located on the outskirts of the city of Ukiah in Mendocino County, northern California. According to the U.S. Census Bureau (Reporter, 2009-2020) the PPN counts a population of 209 citizens. The PPN's mission statement, as published on their web page, reads,

The Pinoleville Pomo Nation secures tribal government, affirms and protects tribal sovereignty, and maintains government-to-government relationships. The Nation is dedicated to developing and maintaining cooperative alliances that benefit the Nation and local community. The Nation is committed to the preservation of its history, culture, and traditions. The Nation provides for the health, safety, and general welfare of its citizens while promoting economic self-sufficiency and personal independence.

Similarly, their vision statement reads,

We see our community being healthy spiritually, physically, emotionally and mentally. We will become independent and self-sufficient through economic development. Self-governance will be carried out through leadership focused on cultural and traditional values, taking actions needed to bring our people into balance. We see ourselves passing on the knowledge and wisdom of our ancestors to future generations and encouraging understanding with communities outside of our own.

In alignment with its mission and vision, the PPN makes use of federal and state funds to support a variety of services that revolve around the wellbeing of its citizens and community. Services such as rental assistance, educational activities, cultural activities, and child care assistance are promoted by the tribe's nine departments (Health and Human Services, Education Services, Highway Safety Program, Environmental, Native American Early Head Start, Vocational Rehabilitation, Housing, Social Services, and Self-Governance (PPN, n.d.)). For a more detailed account of the

different departments and their initiatives, please refer to Appendix 1A.

History

The roots of the Nation go back to *Be-lo-kai* (meaning verdant valley), currently called Potter Valley. Before settlers arrived, there were three main villages and many smaller villages and camps.⁶ All these peoples shared a common language that is presently known as Northern Pomo. The word ‘Pomo’ comes from the name of a village, *Pomo Poma*, with ‘po’ meaning “something valuable” and ‘mo’ meaning both “hole” and “magnesite bead.” Its usage to designate a linguistic group of seven languages is attributed to an unspecified ethnographer (PPN, n.d.).

Politically, Pomo villages were governed by minor councilmen, who are also referred to as Captains. These leaders were chosen for their skills or power, and their positions were commonly passed down the family line. Alliances were established through marriage and ceremonial gatherings. Outfit doctors (men) and sucking doctors (women or men) fulfilled an important role in the lives of Pomo peoples. Some of their healing practices (e.g., ceremonies, songs, and herbs) were passed down while other knowledge came through dreams. Religious and other types of ceremonies (e.g., to ensure and give thanks for a good harvest, to mark a new phase in a person’s life) were central in the lives of Pomo peoples (PPN, n.d.).

Pomo peoples were nomadic hunter-gatherers. They moved with the seasons to stock up with supplies. Early in the year, they would gather clover and other greens. During the spring they would gather seaweed, abalone, and shellfish to dry for use during the winter. In summertime, berries were abundant and some people would occasionally visit the coast to acquire more seafood. Fall offered acorns, a staple food for Pomo peoples, which were carefully gathered and stored for the winter. Hunting was done throughout the year. Deer and Elk meat was dried and stored for winter. During winter, people would devote time to making artifacts needed for everyday life. They would also make beads from clam shells and magnesite that they could later use as a medium of exchange (i.e., money). Feathers gathered through the year were used to make regalia for dancing and singing at ceremonies and celebrations. Additionally, the Pomo people were (and are) superb basket makers. Their baskets have become collectors’ items with world renown (PPN, n.d.).

Settlers from Spain and Russia started to arrive in California in the early 1800’s⁷; however, the Pomo peoples in Potter Valley were relatively removed from the battles, new diseases, and forced servitude. This temporary peace changed with the Gold Rush (~1848-1855). During this time, the number of settlers disproportionately increased, and although there were treaties proposed to guarantee lands for Indigenous peoples, these treaties were not ratified. California Law declared all unclaimed land to be public and open for settlement.⁸ In 1853, settlers arrived in Potter Valley, and the Pomo peoples were dispossessed of their lands and forced to move to the infertile periphery as their ancestral lands were taken up for ranching (PPN, n.d.).

In 1871, most of the surviving Pomos were rounded up by militia and brutally forced to walk to Round Valley Reservation—an event known as Bloody Run (Figure 1.2a). The poor living conditions in the reservation and broken promises of land and support induced a large group of Potter Valley Pomos to leave the reservation, purchase 51 acres of land on the north side of Ukiah, and

⁶ Villages were traditionally composed of a few families who intermarried with people from other villages and tribes. The sizes of the villages ranged from as few as five houses to as many as 100.

⁷ Era of Ethnic Cleansing or Removal era.

⁸ In 1851, the U.S. Federal government made a proposed treaty with Pomo Tribes to reserve lands for tribes if the tribes relinquished the rest of the Lands in California. One year later, the treaties were rejected by the Senate, an action that was kept secret until 1905.

relocate there (Figure 1.2b). However, the tribe's funeral practices (ceremonial cremation and loud wailing practices that could last days) made Ukiah residents extremely uncomfortable. Thus, in 1893 the Pinoleville and other Northern Pomo Captains joined and traded their land for 100 acres located further away from the town (between Ackerman Creek and Orr springs road). This was the place where Pinoleville people settled. In 1905, a survey conducted by the Bureau of Indian Affairs (BIA) concluded that the privately-owned land was overcrowded, and in 1911, the Homeless, Landless Indian Act financed the purchase of neighboring private land to form the Pinoleville rancheria.

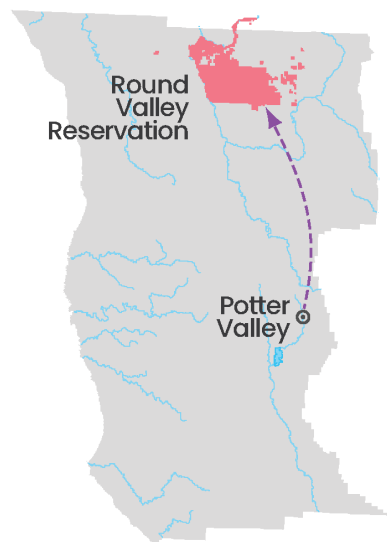


Figure 1.2a. 1871 – Bloody run: Surviving Pomos were brutally forced to walk to Round Valley Reservation

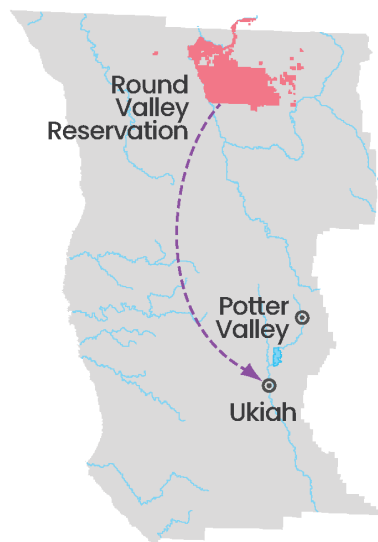


Figure 1.2b. Large group of Potter Valley Pomos leave the reservation and relocate on the north side of Ukiah on their recently purchased land

Presently, and as a result of the termination policy of 1966, the PPN has members scattered around northern California. In 1983, the PPN was part of a class action suit against the federal government which won federal recognition for 17 terminated tribes (PPN, n.d.). In 2003, after 20 years, the tribe was forced by the Bureau of Indian Affairs (BIA) through a reorganization process to research and document their legitimate base roll (a list of original members as designated in foundational documents of the tribe). In 2005, the tribe conducted an election that approved the Tribe's Constitution, and it is now governed by an elected council of seven members who serve terms of four years. In 2006, the tribe signed the Title IV Compact with the U.S. and is finally recognized as a Self-Governing tribe (PPN, n.d.).

Having briefly reviewed the history of the PPN and the PPN-UCB partnership, I next explain the purpose of this study of a particular co-design project enacted within that partnership.

Purpose

This case study explores a three-year-long design trajectory wherein the PPN-UCB team jointly conceptualized an *Indigenous Making Learning Ecology Centered in Wellbeing*. In-depth analyses aim to capture not only design processes and products but also shifts and complexities that emerged for the project team and the work that was undertaken to resolve these tensions. The purpose of engaging in such in-depth analysis is to better understand adequate practices when non-Indigenous novice

designers work with Indigenous communities, particularly when co-designing transformative learning ecologies. Subservient to the aforementioned purpose, this work also aims to contribute to the co-design literature devoted to understanding ways in which non-dominant worldviews can get filtered by dominant perspectives.

Research Questions

Aligned with this work's purpose, the following question served as a compass throughout the design process: "What are the best practices when non-Indigenous novice designers work with Indigenous communities to co-design a transformative learning ecology anchored in making and wellbeing?" In turn, this design question inspired the following more specific research questions that will be explored in this dissertation:

RQ1a. How was the co-design of a culturally sensitive makerspace instantiated in practice?

RQ2a. What shifts, if any, were triggered when the researcher encountered Indigenous worldviews during the co-design process?

RQ2b. What factors mediated the identified shifts?

RQ3a. What are community members' perspectives around wellbeing and STE(A)M fields?

RQ3b. What connections, if any, do participants see between these two areas? Conversely, what tensions emerge?

Research Context

Given that the project revolves around the design of an Indigenous-serving makerspace, this literature review provides an overview of *making* in education. I start by providing a brief historical account that traces the origins and popularization of *making* to the *maker movement*. Through a review of work in the field, I examine the contributions and potential challenges of *maker education* (Barajas-López & Bang, 2018a; Blikstein, 2013; Buechley, 2013; DiGiacomo & Gutiérrez, 2016; L. Martin, 2015; Vossoughi et al., 2016). I then explore the work of Indigenous scholars who, through historicizing the practice of *Making*, have reclaimed and reconceptualized it as an ancestral cultural practice. I close by identifying design principles that prominent scholars in the field have put forward when designing emancipatory learning ecologies together with non-dominant communities.

Making in Education

Over the last two decades, *making* has gained acceptance in the educational sphere, especially in and around STE(A)M fields. Its popularity among educators, researchers, policymakers, and the public in general can be evidenced by the proliferation of makerspaces both in schools and in out-of-school settings. Proponents of *making* as an educational paradigm emphasize the value of creating and sharing interest-driven artifacts as a way of challenging decontextualized forms of learning and allowing children to express ideas in powerful ways (Blikstein, 2013; Halverson & Sheridan, 2014). One of the main goals of learning through *making* is to engage learners in personally compelling, creative, and meaningful inquiries of the socio-material world (Blikstein, 2013), engaging in rich cycles of "hands-

on, heads-in” work (Ackermann, 2001).

Some scholars have also pointed out that maker education might eventually result in the expansion and diversification of participation in STEM fields (Brahms, 2014; L. Martin, 2015). However, achieving these equitable educational outcomes will depend largely on the ideological lenses that guide the design and implementation of *making* activities (Vossoughi et al., 2016). It is worth noting that in hegemonic conceptions of equity, the issues around diversity and inclusion are thought to be resolved by providing non-dominant communities access to colonial systems, rather than by challenging the system itself.

In historicizing the ideologies of the Maker Movement, it is crucial to point out that, much before its large popularization in the 2000s, there were many scholars who had envisioned the pedagogies, technologies, applications, and even critiques that would later be amplified. In 1990, Jeanne Bamberger published a foundational article on her “Laboratory for Making Things,” (Bamberger, 2014) which was one of the first documented physical spaces in a public school dedicated to technology-based creative endeavors. Her focus, which would later find echo in maker education, was to develop spaces, methodologies, and contexts in which children could express diverse ways of thinking, creating, and solving problems. Some years later—yet still years before the Maker Faire—Mike Eisenberg envisioned the use of digital fabrication devices as educational tools, proposing the use of new “output devices” such as 3D printers in education (Eisenberg, 2002). His focus, counter to much of the “ICT education” debate at the time, was on using these once industrial machines as expressive devices in the hands of children. One of Eisenberg’s doctoral students, Leah Buechley, would later take these ideas further, claiming that the solution to the overly-masculine culture around computation and engineering would be solved by creating entirely new cultures around those disciplines. As a result of this work, Buechley pioneered the use of e-textiles and other new types of materials such as paper (Buechley, Eisenberg, Catchen, & Crockett, 2008; Buechley, Elumeze, & Eisenberg, 2006). Pioneers such as Bamberger, Eisenberg, and Buechley regarded these early “maker” environments, tools, and technologies as culture-building elements in the creation of entirely new types of spaces, pedagogies, and activities for children, honoring their brilliance and diversity. In the following years, many other scholars created new experiences, tools, and contexts for taking these types of pedagogies to different populations in the U.S. and abroad (e.g., (Blikstein, 2008; Millner, 2010), generating a fertile ground for modalities of maker education that did not follow the format that would later become part of its mainstream Silicon Valley version.

This mainstream version was further problematized by critical scholars who pointed out that the worldview of a given community could determine what counts as making and who gets positioned as a maker (Barajas-López & Bang, 2018a; Vossoughi et al., 2016). Such messages are rarely explicit, but rather seep into learners’ experiences through the artifacts, texts, spaces, and discourses adopted in the learning environment. This implicit messaging becomes increasingly problematic when a hegemonic community rules over historically subjugated populations. For example, critical scholars of learning have shown that the “original,” Silicon Valley-based *maker movement* was mainly constituted by white middle-class communities of practice (Buechley, 2013) and imbued by neoliberal interests and techno-utopian ideologies (Vossoughi et al., 2016). Understanding the origins and development of *making* in education allows for a critical analysis that not only sheds light on how culture and power shape learning in maker environments but also affords a re-envisioning of its future.

History and Background

The popularization of *making* in education can be traced to the *maker movement*. This movement resulted from the successes of the open-source and DIY movements, the growth of FabLabs, and the Make: Magazine and Maker Faire. Halverson & Sheridan (2014, p. 496) explain that the maker movement

refers to the “growing number of people who are engaged in the creative production of artifacts in their daily lives and who find physical and digital forums to share their processes and products with others.” Consequently, it is a movement with which many designers, independent inventors, hobbyists, tinkerers, engineers, hackers, and artists identify (L. Martin, 2015). Bjarin (2014) further claims that the maker movement aligns with U.S. values of self-reliance, innovation, creative expression, entrepreneurship, and love of new technologies. Other authors refer to it as a ‘new industrial revolution’ that enables personalization to proliferate through the use of digital fabrication tools, suggesting that independent, small-scale entrepreneurs could ultimately challenge the monopoly of large corporations (Anderson, 2012). The extraordinary popularity of the maker movement among laypeople, policymakers, educators, and researchers has fostered the creation of many non-profits and academic initiatives around it.

Responding to the more recent growth of the maker movement, Blikstein (2013) voiced the potential for improving learning by connecting *making* with formal education. He claimed that, although the theoretical pillars⁹ of maker education had been around for more than a century, the advent of suitable social and technological infrastructures, such as the sharp reduction in the cost of digital fabrication/physical computing technologies, and countries’ interest in developing economies based on innovation, allowed making in education to gain enormous traction (Blikstein, 2018). The wide acceptance of the maker movement in education is evidenced by the burgeoning number of makerspaces in K-12 schools, institutions of higher education, libraries, and museums (Halverson & Sheridan, 2014) and by the high hopes that have been placed on its potential to expand and diversify participation in STEM fields (Barton, Tan, & Greenberg, 2017; L. Martin, 2015).

The spaces for *making*, called makerspaces, hackerspaces, or FabLabs, are a key element of the *maker movement*. Halverson & Sheridan (2014) define such spaces as “communities of practice constructed in a physical place set aside for a group of people to use as a core part of their practice” (p. 502). While the character of these physical spaces varies tremendously, they are frequently associated with cutting-edge technology for digital fabrication (e.g., 3D printers, laser cutters, CNC machines, etc.). However, in more recent years, many of them have started to include low-cost and low-tech tools as well.

Power and Culture in Making

As *the maker movement* started to outgrow its private, for-profit sphere, gaining traction in the educational realm and spreading its subculture, researchers from different schools of thought on education reacted by drawing attention to narrow notions of *making* and *makers* that the movement had set in place. Leah Buechley (2013), a prominent constructionist researcher, was the first to turn a critical eye to this mainstream version of the movement. While she acknowledged that the movement provided visibility and an “opportunity to work with our hands and brain together,” her pioneering analysis of Make: Magazine covers (2013) revealed a very narrow depiction of both what making is and who were considered to be makers. For example, in her sample of 36 covers from volumes of the magazine published over eight years, 53% of the covers depicted electronics, 31% vehicles, and 22% robots. In this sample, 85% of the covers portrayed men and boys, and only 15% depicted women or girls. Strikingly, there was no representation whatsoever of people of color. By raising examples of rich cultural traditions of making, such as Afro-Caribbean Carnival costumes and American Indian

⁹ School-based maker education relies on the following theoretical pillars: a) interest-driven curricula, b) project-based pedagogies, c) constructivism and constructionism, d) critical pedagogy, and e) low-cost technological tools (Blikstein, 2018; Halverson & Sheridan, 2014; L. Martin, 2015).

Pueblo pottery, that had been overlooked by the Make: Magazine community, Buechley strongly criticized the *Maker Education* Initiative currently known as *Maker Ed*. She acknowledged that such cultural tunnel vision is “okay for an inconsequential subculture” with a magazine “that’s about guys doing what they love to do.” However, she expressed profound reservations when the same initiative promises to “reach every child.” Buechley’s analysis did not convince her that Make: had thought about how to reach a diversity of people, or that they cared about connecting with a diversity of people. A consequence of such a narrow depiction is that it disenfranchises and makes invisible communities who have historically engaged in creative endeavors and Making practices, out of necessity or leisure, but do not benefit from dominant economic structures (Buechley, 2013; Vossoughi et al., 2016).

Following Buechley’s criticism, critical cultural-historical scholar Shirin Vossoughi and her colleagues have agreed that current notions of making are too limited. At least in the U.S., most of the movement has been led by white middle-class communities of practice and, in many cases, guided by neoliberal interests (Barton et al., 2017; Vossoughi & Bevan, 2014; Vossoughi et al., 2016). For example, Dale Dougherty’s¹⁰ 2011 TED Talk, as analyzed by Vossoughi et al. (2016), depicts making as “uniquely American,” connected to “playing with technology,” and focused “on technological forms of innovation that advance hands-on learning and contribute to the growth of the economy” (p. 207-208). A report by the California Council on Science and Technology (Feinstein, DeCillis, & Harris, 2016) illustrates other underlying ideologies in their claim that makerspaces “would help community colleges to position themselves as key stakeholders in their region’s innovation economy” and that students who engage with such spaces will most likely develop 21st-century learning and literacy skills, “which are key skill sets for entrepreneurs [...] and those in the STEM economy” (Feinstein et al., 2016, p. 7). From these and other less restrictive but still limited perspectives, we can infer that the most popularized version of making is based on models around human capital theory, and around neoliberal and techno-utopian ideologies. Mainstream narratives showcase making as a proxy for STE(A)M fields, which in turn are a proxy for technological and commercial innovations for the sake of the economy (Vossoughi et al., 2016).

In conclusion, although the ubiquitous calls for educational approaches that foster creativity, inventiveness, and equity suggest that making and makerspaces in education have great potential, some scholars emphasize that this potential is subordinated to the way making is conceptualized and positioned relative to historical, every day, or othered forms of making (e.g., cultural medicine making, material repair, sewing for economic survival) (Barajas-López & Bang, 2018a; Vossoughi et al., 2016). Moreover, making practices and makerspaces reflect practitioners’/designers’ (implicit) ideas around who should have agency in the making process, in turn shaping the types of relationships afforded between people, machines, materials, digital models, etc. in these spaces (Devendorf & Ryokai, 2015). Likewise, Barajas-López and Bang (2018a) claim that allowing for “cultural variation in meanings of and relations to materiality” (p. 9) and the disruption of dominant forms of material use are essential to creating makerspaces that promote equity and transformative learning for non-dominant youth.

Indigenous Making and Sharing

Given the history of colonialism and the intentional erasure of Indigeneity throughout the world

¹⁰ CEO and Founder of Make Media, publisher of Make: Magazine. The maker city website provides the following description: “He [Dougherty] has been called the ‘godfather of the Maker [M]ovement,’ having founded both the magazine and the first Maker Faire in 2006. Dale was instrumental in launching the Maker [M]ovement, which is reshaping science and technology education and creating unprecedented economic opportunity for young people and a renaissance in urban manufacturing.” (n.d., 2021)

(Grande, 2015; Urrieta, 2016), the narrow connotations of making in the U.S.—and their subsequent popularization across the globe—have prompted Indigenous scholars to argue for historicizing the practice of making. Reclaiming and reconceptualizing making as an ancestral cultural practice allows for multiple perspectives on the aims, relationships, and identities afforded by making activities. Opportunities to define the pillars of making and its socio-political values open up space for the enactment of the sovereignty of communities rooted in different historical and cultural genealogies. This, in turn, expands the potential of *makerspaces* to foster equity and emancipatory educational experiences (Barajas-López & Bang, 2018a; Vossoughi et al., 2016).

Based on this broad reconceptualization of *Making*, Barajas-López and Bang (2018b) define *Indigenous Making* as a human practice that revolves around family and communal responsibilities and entails deep nature-human relations. *Making* is a process of knowing, being, and doing (K. Martin & Mirraabooa, 2003) that reflects epistemic practices and thus impacts how people engage with materiality and nature (Barajas-López & Bang, 2018b).

Relationship to Technologies and Materials

Considering Indigenous Making requires a further discussion of how culture and sociohistorical contexts mediate the conceptualization of technologies and materials as well as people's relationships with them. Presently, it is commonly assumed that technologies are intrinsically tied to notions of novelty and innovation. For example, when asked to provide an example of technology, most people will mention things like smartphones, laptops, or robots. Concomitant to this particular way of perceiving technology is the demotion or even erasure of traditional technologies such as agricultural or crafting tools, architectural practices, or means of transportation (Bang, Marin, Faber, & Suzukovich III, 2013). Moreover, these traditional technologies are frequently deemed irrelevant to contemporary problems and solutions (Barajas-López & Bang, 2018a).

While views on the relationship between Indigenous peoples and technologies vary significantly—from the association of modern technology with hegemonic agendas to requests for increasing youths' access to the latest technologies—Bang, et al. (2013) suggest that common to all these narratives is a notion of technology that is shaped by Western paradigms and societies. In a line similar to the critique around limited notions of making, these researchers advocate for an expansive definition of technologies. Seeing technologies as tools rooted in historical and contemporary practices is more appropriate because it acknowledges that all cultural communities have developed and used local technologies while also being skillful in adopting foreign ones (Bang et al., 2013)—throughout time and across geographical locations.

Contemporary discussions around making in education, particularly in STEM fields, intrinsically assume that materials are passive and subservient to human designs. Ingold (2010) explains that this hylomorphic model of creation—characteristic of Western traditions and whose origins can be traced back to Aristotle—grants full agency to humans while viewing matter as inert. However, Indigenous worldviews based on relational and non-hierarchical human-nature relationships contest that model. Ingold (2013) proposes a conceptualization of making as a process of growth, where the maker is positioned “from the outset as a participant in amongst [sic] a world of active materials. These materials are what he has to work with and in the process of making, he ‘joins forces’ with them ... in anticipation of what might emerge” (p. 21). In summary, considering a non-hylomorphic (or morphogenetic) view of making that positions materials as active and in communication with the maker through their physical properties will better suit the aims of this project.

Co-designing Indigenous Making and Sharing Initiatives

From the time Barajas-López and Bang (2018b) published their work on Indigenous Making and sharing, scholarship around this topic has been growing; however, it is still an underexplored area of research. Most of the available literature focuses on researching and analyzing participants' work within a course, workshop, or other ready-made curriculum. Largely absent are descriptions and analyses of the specificities and challenges of using a co-design process to create learning environments to sustain such experiences, particularly when the design processes are mainly guided by novice non-Indigenous designers/researchers. That is, the existing literature speaks to community members' experiences and learning in making and sharing projects and offers less guidance to researchers looking to pursue such work.

To review the existing literature on the design of Indigenous-serving makerspaces, I build on Hamilton and Morgan's (2022) systematic review of Indigenous making and sharing initiatives for Indigenous youth. Of the 20 articles they identify, some either explicitly mention or imply some sort of participatory design (e.g., co-design, community-based design research) with Indigenous communities (Bang et al., 2013; Barajas-López & Bang, 2018a; Carlson, Hardman, & Marczak, 2011; Eglash, 2007; Kafai, Searle, Martinez, & Brayboy, 2014; Tzou et al., 2019), but none provide a detailed account or analysis of the design process itself. In the following paragraphs, I will refer to the best examples of the articles that mention participatory design as a methodology. I place particular emphasis on the details the authors provide about the design process, and also comment on some missing elements that could aid a designer in such work.

Bang et al. (2013) study a community-based, middle school science learning environment serving students in the Chicago American Indian community. They cite Community-based Design Research as their guiding methodology and detail who participated in the design process (elders, parents, teachers, community content experts, degreed experts, other interested adults, and youth) and how the design decisions were made (bimonthly community designer meetings followed by piloting and revision through four design-implementation cycles). However, they do not address the nuances of the design process itself (e.g., the design methods they used, or shifts and tensions that might have arisen) and the extent to which different community members participated in these processes.

In describing TechTales, a family-based robotics workshop grounded in storytelling, Tzou, et al. (2019) cite Participatory Design Research (PDR) as their guiding methodology. They mention that the workshop was developed by learning scientists, public library staff members, informal science educators, and staff members from Native-American-serving organizations but do not provide more details about the design process. The reader is left wondering about what the interaction between these stakeholders looked like, how frequently they met, and the extent to which local Native American peoples were represented.

In a culturally-based STEM program at a northern Minnesota Bureau of Indian Education high school, Carlson et al. (2011) explain that reservation teachers and university faculty collaborated to develop an approach that blended Western and Indigenous science content and delivery. The authors mention that the university team went to the reservation 2-3 days each month, but do not clarify whether these interactions were part of the design process or the implementation of their Reach for the Sky project. While the authors provide a list of key program components, they do not focus on how those components were jointly created.

Finally, Kafai et al. (2014) describe formal and informal Ethno E-textiles (e2textiles) workshops that served Native American youth. The authors provide a succinct description of the design process, mentioning, for example, that the development of the unit followed two design-implementation cycles. However, the authors do not detail the participation of staff from the Cultural

Resources Department or the American Indian Studies program at a local community college in these design efforts.

In sum, available scholarship is mainly devoted to analyzing issues linked to the *implementation phase* of the projects. When a description of the (co)design process is specified, it is done to frame the study by providing the reader with a very general picture of the project that has been implemented. This evidence shows a gap in the literature about best practices, specific considerations, challenges, conceptual shifts, and opportunities in co-design processes involving novice non-Native designers/researchers and Indigenous communities.

Orienting Framework

Three frameworks lie at the heart of this dissertation project. From the inception of the project, design thinking (Beckman & Barry, 2007; Owen, 2007)—an approach that originated mainly within the fields of architecture and engineering—has been a useful pragmatic tool that has guided the design process of the makerspace project itself through notions such as use, usability, and meaning-based needs. Cultural-historical perspectives on learning, for their part, have provided theoretical rigor linked to learning and societal transformation. Finally, Holistic Ecological Perspectives represent Indigenous ontological and epistemological views. These three frameworks represent my background as a non-Indigenous designer, who has been formally trained as both an engineer and a learning scientist, and who works with an Indigenous community. In the following sections, I will provide a brief overview of each.

Design Thinking

While there is no agreement on a precise definition for *design thinking*, academics usually agree that it captures the intangible work done by designers.¹¹ Kimbell (2011) refers to architect Peter Rowe’s book *Design Thinking* (1991) as one of the first accounts where the term is used. However, Rowe’s publication was part of an already existing conversation around design. In the USA and Europe, scholars trace the genesis of design research—the description of what design is, and how to do it—to the work of the Welsh engineer John Christopher Jones, the Austrian architect Christopher Alexander, and the U.S. political scientist Herbert Simon. While the historical contextualization of design as a field allows for a deeper understanding of *design thinking*, such an account goes beyond the scope of this document (for this kind of analysis see Kimbell (2011) and Kimbell (2012)). Johansson-Sköldberg, Woodilla, and Çetinkaya (2013) suggest that *design thinking* acquires diverse meanings depending on the context where it is used and identify two prevalent discourses, one in the scholarly sphere and another in the managerial world. In the former, ‘designerly thinking’ connects theory and practice from a design perspective and is grounded in the academic field of design. In the latter, also regarded as a professional design practice, the discourse around *design thinking* reveals a simplified version of ‘designerly thinking’ – that is, key takeaways that can be used for and with people without a scholarly background in design, particularly in management (Johansson-Sköldberg et al., 2013).

Design thinking can be thought of as a process that follows Sara Beckman and Michael Barry’s Innovation Model (2007). This model moves the design team “between the concrete and the abstract

¹¹ Given the lack of consensus and inconsistency in definitions, some use the terms “design thinking,” “human-centered design,” “participatory design,” “co-design,” and “user-centered design” interchangeably. However, for the purposes of this dissertation, I do differentiate between these terms.

worlds, and it alternately uses analysis and synthesis to generate new products, services, business models, and other designs” (2007, p. 9). Although the authors explicitly acknowledge that the process is not linear, for the sake of simplicity they present it as a sequence of four stages (Figure 1.3). The first one, ‘Observations’, entails generating observations of the stakeholders. Second, in the ‘Frameworks’ phase, designers move from the concrete to the abstract to identify what is important to the stakeholders by framing and reframing the data collected. The third step distills the insights from the previous step to define a set of goals the innovation needs to accomplish and uses those as a springboard to imagine and design new ways (‘Imperatives’) to address these challenges. In the fourth and final step, ‘Solutions,’ designers go back to the concrete realm to experiment and learn whether the solutions in fact fill the gaps and address the challenges identified.

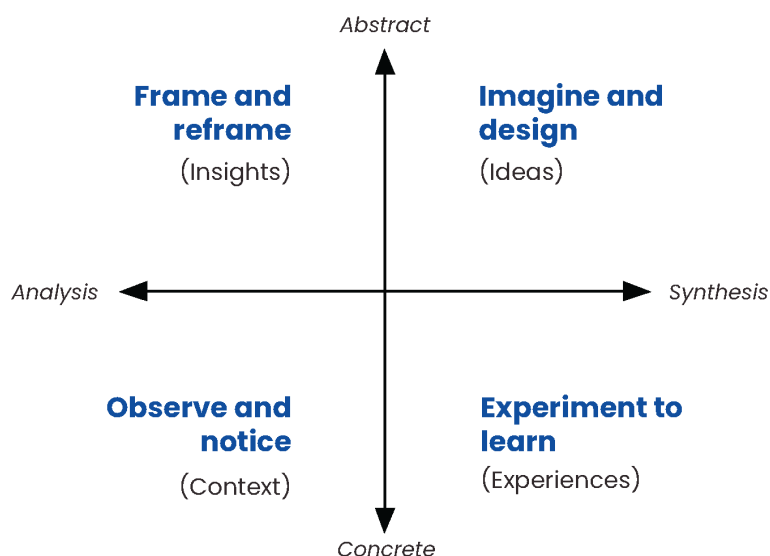


Figure 1.3. Design thinking as an innovation process. *Source: Adapted from (Beckman & Barry, 2007)*

Cultural-Historical Perspectives on Learning

To better understand the design of an Indigenous Making Learning Ecology, it is important to situate the project within the landscape of the Learning Sciences and educational research. Therefore, as a brief introduction to this section, I present three broad theoretical perspectives within the realm of educational research along with their specific views on knowing and learning (Greeno, Collins, & Resnick, 1996). To better understand the alignment of cultural historical theoretical views of this study, I briefly contrast it with more traditional views of learning and development. The *behaviorist perspective* views knowing as having an organized collection of associations and skills, and learning as the process in which these associations and skills are acquired and applied (Greeno et al., 1996). The *cognitive perspective* conceptualizes knowing as having structures of information and processes that recognize and construct patterns of symbols in order to understand concepts and to exhibit general abilities (e.g., reasoning, planning, meta cognitive processes). Learning within this tradition is defined as a constructive process of growth of cognitive abilities and of conceptual development where said organized structures result from the reorganization of concepts in the learner’s understanding (Greeno et al., 1996). Finally, the *situative or cultural-historical perspective* sees knowing and learning as participation in mediated social practices.

The theoretical commitments of this dissertation project reside within the socio-cultural perspectives on knowing and learning. This tradition positions knowledge as both a characteristic of

groups that conduct joint activities and an attribute of individuals who participate in their communities. Following this line of thinking, learning by a group or individual is viewed as becoming attuned to the constraints and affordances of material and social systems through participation (Cole, 1998; Cole & Engeström, 1993; Greeno et al., 1996; Vygotsky, 1978).

In particular, this dissertation aligns with a scholarly genealogy that challenges oppressive discourses and economic structures through the development of emancipatory design sensibilities, pedagogies, and learning ecologies together with non-dominant communities (Barajas-López & Bang, 2018a; Freire, 1970, 1974; Gutiérrez & Rogoff, 2003; Moll, Amanti, Neff, & Gonzalez, 1992). Scholars within this tradition sustain that meaning arises from participation in culturally organized activity; consequently, understandings of culture are central. Historically speaking, culture has been portrayed as a static notion that, among other things, has been used to essentialize and police Indigenous authenticity (Smith, 2013). Therefore, a more nuanced and complex understanding is required to make justice for Indigenous communities without portraying them as relics of history being analyzed in a monochromatic light (Urrieta, 2016). Culture is a highly fluid notion that is inextricably tied to peoples and their contexts, and unavoidably offers resources and constraints. K. Gutiérrez and Rogoff explain that people “*live* culture in a mutually constitutive manner in which it is not fruitful to tote up their characteristics as if they occur independently of culture, and of culture as if it occurs independently of people” (2003, p. 21). Furthermore, a non-normative, non-integrated view of culture enables an understanding that typically there is more variance within groups than there is across groups (Gutiérrez & Rogoff, 2003).

The socio-cultural tradition sees human cultural knowing as a mediated activity. Cole (1998) is a proponent of thinking of culture as a medium and a context—that which surrounds and that which weaves together. Artifacts—both ideal and material—are essential constituents of culture, and their existence is predicated on their relationship to something else (e.g., situation, context, activity) (Cole, 1995, 1998). Based on these notions, it makes sense that co-design projects with non-dominant communities should pay special attention to cultural mediation as it provides a natural link between action (external and internal), and the cultural, institutional, and historical contexts in which such action occurs (Wertsch, 1998).

Learning, within this tradition, is a community process of *transformation of participation* in sociocultural activities (Cole & Engeström, 1993; Lave & Wenger, 1991; Rogoff, Matusov, & White, 1996). Concepts are not seen as abstracted, fixed, well-defined, independent entities because doing so would overlook important insights into “either the culture or the authentic activities of members of that culture that learners need.” (Brown, Collins, & Duguid, 1989, p. 33). In other words, learning is defined as a process of enculturation or participation. If this is the case, it is unavoidable to ask what cultures have been historically privileged, and who are the real—direct and indirect—beneficiaries of such enculturation (Bang, 2015; Freire, 1970). The foundational work of Freire (1970), Gutiérrez & Rogoff (2003), and Moll et al., (1992) has been crucial to challenging deficit-model thinking, in which cultures “that differ from the practices of dominant groups are judged to be less adequate without examining them from the perspective of the community’s participants” (K. Gutiérrez & Rogoff, 2003). Thinking in terms of Repertoires of Practice (Gutiérrez & Rogoff, 2003) or Funds of Knowledge (Moll et al., 1992) is essential to establishing an authentic dialogical relationship with non-dominant populations.

Holistic Ecological Perspectives

The value of refuting prevalent educational discourses and practices lies in its potential to better serve populations, such as Indigenous communities, whose worldviews have been historically ignored and

devalued. By aligning educational endeavors to *holistic ecological perspectives*, I challenge the normalized interpretation and use of human capital theory, pervasive in STE(A)M educational spheres worldwide. Although the idea of STE(A)M as a gateway to individual economic prosperity has been seen as universally truthful, it represents selected mainstream voices, and it might not—by itself—resonate with the ethos of Indigenous communities. Working with Indigenous communities requires a deep dive into frameworks put forward by Indigenous scholars and thinkers since even taken-for-granted assumptions from educational research might not apply (e.g., anthropocentrism). For example, in a talk, Navajo scholar David Begay (2020) explained that underlying Indigenous thinking is the “perception that all things are naturally interconnected.” Martin & Mirraboopa expand on this idea by stating that “[all things should be] recognized and respected for their place in the overall system” (2003, p. 207). Becoming more familiar with Indigenous worldviews and onto-epistemic notions allowed me to recognize *holistic ecological perspectives* (Begay, 2020) as a better way to relate to the wisdom of Indigenous peoples.

From a holistic ecological perspective, humans and nature are not separated, and things considered not alive by Western standards “are alive through their interconnectivity with those living” (Begay, 2020). K. Martin and Mirraboopa (2003), aboriginal thinkers from Australia, elaborate on this idea when they describe that thinking of place or country does not only evoke “the Land and the People,” but also the “Entities of Waterways, Animals, Plants, Climate, Skies and Spirits” (p. 207). They also explain that although humankind is no more or less important than the other Entities, humans have a role to fulfill in the world. This view is captured in the narrative of a Quandamooka wise woman: “[a]ll living things, be they mammals, birds, reptiles, insects or trees are our sisters and brothers, and therefore we must protect them. We are their custodians. We not only share with them, we also guard them” (cited in K. Martin and Mirraboopa (2003)).

One can better understand holistic ecological perspectives after engaging with Indigenous views on ontology and epistemology. Wilson (2008), an Opaskwayak Cree researcher, explains that relationality is at the core of both Indigenous ontology and Indigenous epistemology. He explains that a relational ontology sustains that relationships do not merely shape reality, *they are reality*, and that a relational epistemology maintains that Indigenous systems of knowledge are built by and around and also form these relationships. Relationality implies that nothing can be without being in a relationship, without its context (Cajete, 1994; Elk, 2016). To better explain these ideas to people in dominant society, research, and academia, Wilson (2008) specifies four dimensions: relations to a) People, b) Land/Environment, c) Cosmos, and d) Ideas. (For a full description of each category, please refer to Chapter 6 of this dissertation.) In short, a relational ontology, central to many Indigenous worldviews, sees reality as a web of connections and relationships that transcend the present time to include the past and the future. In contrast, a relational epistemology implies that systems of knowledge, besides being built by and around these relationships, also constitute them.

Drawing on the related notions of relational ontology and holistic ecological perspectives, it seems safe to conclude that, from an Indigenous viewpoint, ideas around flourishing and wellbeing must include all earthly life, sentient and non-sentient, vegetal, animal, and mineral. Thus, for some, talking of flourishing from a holistic ecological perspective inextricably entails human flourishing and wellbeing. Nevertheless, the opposite does not necessarily hold true. Along the same line of thinking, flourishing under a holistic ecological perspective could also be misunderstood when seen through a humanistic/anthropocentric lens. The separation of people from the world around them allows for interpretations that ignore human flourishing. Imagine a vegan white male supremacist and environmental activist who believes that immigration must be radically curtailed to preserve the U.S. environment. This hypothetical subject purports to care immensely about the wellbeing of the natural environment surrounding him, but his benevolence does not extend to social justice issues. The key takeaway from these examples is that core to flourishing and wellbeing from a holistic ecological

perspective are notions of relationality, the inseparability of culture and nature, and the non-hierarchical relationship between humans and nature (Cajete, 1994, 2000; Durán-López, 2010; Wilson, 2008).

To summarize, cultural-historical perspectives on learning provide the theoretical and analytic machinery needed to recognize and study different cultural dynamics and worldviews. Holistic ecological perspectives orient me specifically to issues of relationality within Indigenous worldviews. Design thinking offers a way of conceptualizing and understanding design as an iterative process, and offers concrete strategies for engaging in design work. Specifically, the combination of cultural-historical perspectives and design thinking facilitated work with community members toward creating learning ecologies inspired by holistic ecological perspectives. Having reviewed the three theoretical frameworks that ground this project, I next situate the project's design methodology within traditions from both engineering design and the learning sciences.

Participatory Design

In their design work, engineers and learning scientists often employ the same or similar terms with different associated meanings and practices. This section addresses one term in particular: participatory design. I first trace its unique origin before outlining how, in the field of engineering design, it became a domain-general design tool¹² while, in the learning sciences, it became a particular methodology that maintains its early political commitments.

Origins

Participatory Design (PD) is an approach to design that was born in Scandinavia in the 1970s and 1980s (Spinuzzi, 2005). In its origins, it was linked to technological development and motivated by a Marxist commitment to democratically empowering workers and fostering democracy in the workplace, specifically through partnerships with labor unions that would allow workers to determine how new technologies were introduced into the workplace. Labor unions, inexperienced with computer technologies, were often forced to accept technologies and machinery developed by upper management, disrupting traditional ways of working and increasing the level of control and surveillance—not to mention generating unemployment through automation (Ehn, 2017). Thus, Participatory Design introduced close collaboration between developers and users, with the goal of creating technologies that were better suited to the needs of the people who would be using them (Spinuzzi, 2005).

Participatory Design has changed over time, following many cycles and transformations in the technologies involved and in the theoretical approaches applied. In the 1970s, the focus was mostly on the workplace, transitioning to designing for more general modalities of skilled work in the 1980s, particularly the design of new kinds of computer systems, with a focus on users' perspectives and dehumanization (Ehn & Kyng, 1987). In the 1990s, it concentrated more on establishing an academic community for democratically-inspired Participatory Design, and finally, from the 2000s on, the focus shifted to exploring democratic design experiments “in the small” (Ehn, 2017).

¹² As Kramer (2020) declares, within the field of engineering design, terminology like “participatory design,” “human-centered design,” “design thinking,” “co-design,” and “user-centered design” is contested, not broadly consistent, and sometimes used interchangeably.

Perspectives from the Engineering Design Field

Despite this long trajectory and the many historical cycles, from the engineering design field, Participatory Design methodologies can be thought of as falling along a spectrum of stakeholder involvement (Brubaker, Jensen, Silungwe, Sheppard, & Yang, 2017). At the least involved end, practitioners of user-centered design focus on ‘the thing being designed’ (e.g., the object, communication, space, interface, service, etc.), and position interaction with the users as a means to ensuring that the project meets the users’ needs (Figure 1.4). As a mid-point on the spectrum, co-design engages stakeholders throughout the design process—and sometimes maintain separation between users and designers/researchers. At the most involved end, stakeholder-led design is led or solely conducted by stakeholders themselves.



Figure 1.4. Thinking of participatory design as a spectrum. *Source: Adapted from (Kramer, 2020)*

Perspectives from the Learning Sciences

Broadly speaking, the term “design” is used in the Learning Sciences (LS) to describe the methods used to plan, develop, and iterate various educational initiatives (DiSalvo & DiSalvo, 2014). Design-based Experiments (DbE), the first of such methods that foregrounded design, were later expanded into Design-Based Research (DBR) and grew to be one of the very foundations of the Learning Sciences. Soon, other variations and ideas were created such as Community-Based Design Research (Bang, Faber, Gurneau, Marin, & Soto, 2016) and Participatory Design Research (Bang & Vossoughi, 2016).

Those methodologies are all intertwined and overlap in different ways. In particular, Community-Based Design Research with Indigenous communities has its roots in Participatory Action Research (Bang et al., 2010). PAR is based on working with communities to identify issues and develop plans of action to address those issues. Community-based design research was one of the attempts to bridge these two traditions, and many such attempts are currently being actively pursued by learning scientists (DiSalvo & DiSalvo, 2014).

Furthermore, Bang and Vossoughi (2016) proposed a method called Participatory Design research (PDR). The authors explain that PDR seeks to advance theories of human learning and practices in the service of social justice. It is informed by Cultural Historical Activity Theory and the Change Laboratories that have emerged from it, as well as design research and other critical, participatory, and community-engaged research.

As a common thread, many of these approaches to design in the Learning Sciences are particularly concerned with ecological validity (Cole, Hood, & McDermott, 1994); attention to issues of power, equity, justice, and historicization (Gutiérrez, 2016); and consequentiality (Hall & Jurow, 2015). Further, many of these approaches regard the notion of “experiments” in a very particular way:

...experiment is a trial to take action in the world, to act in it, in order to see what

the consequences of the action are. It's most fundamentally not about modern formal experimental design—with random assignment to control group, and so on—but about acting on the world, trying rather than doing armchair theorizing. (Gutiérrez, 2016, p. 93)

Thus, in contrast to uses within engineering design, participatory design within the learning sciences tends to maintain stronger theoretical commitments to the practice's political origins, seeking functional design that not only comfortably meets users' needs but also transforms their activity in desirable, self-determined ways.

Quality of Participation in Participatory Design

As PD was extended into many contexts, especially replacing top-down, exogenous models in community development projects (Shortall, 2000), the issue of the quality of participation became a central concern for researchers (Hayward, Simpson, & Wood, 2004; Wallerstein, 1999). Hayward et al. (2004), for example, challenged the assumption that the community's participation in a project is always a positive experience for those taking part, and questioned whether it always leads to empowerment, improved sustainability, and solving problems with sensitivity to cultural, economic, and political factors. The conclusion was that “participation is a fluid and contested process that can have contradictory outcomes” (p. 105). The authors bring counterintuitive findings from case studies in which they have observed “participation fatigue,” or lack of consideration for the life commitments and constraints experienced by community members. They also present arguments for considering participation to be both a “means” and an “end.” Participation as an *end in itself* can have many intangible benefits, as it stresses the importance of the *process* and the positive outcomes of participation even independently of the official “goal” of the project:

...even if the bridge is never built, there may be positive outcomes for participants in simply being part of the development project processes. Participants may develop leadership or public speaking skills, extend their social or business networks, or gather new information that is useful to them in other areas of their lives. (p. 102)

Hayward et al. (2004) also highlight a related, possibly problematic dimension of participatory approaches: communities are seldom socially homogeneous, and a handful of spokespeople, typically members in prominent positions, might not speak for everyone. Though it can be hard to determine, the representativeness of participants' contributions should be carefully considered.

Significance

This dissertation addresses a lack of scholarship examining the co-design of makerspaces that aim to cultivate Indigenous wellbeing. More concretely, by analyzing a collaboration between a sovereign Native American Tribe, the Pinoleville Pomo Nation, and a team of non-Native researchers from UC Berkeley, this study seeks to improve design and research efforts in which non-Indigenous novice researchers co-design with Indigenous communities.

Roadmap for the Dissertation

The general question that has guided both the design and the research objects of this dissertation is: What are the best practices when non-Indigenous novice designers work with Indigenous communities to co-design a transformative learning ecology anchored in Indigenous making and wellbeing? Initially oriented by the literature available in the fields of engineering design and the learning sciences, it became clear that the participation of the community throughout the design process is one of the factors to consider. Community participation has been defined as essential to disrupting normative power dynamics between the researchers and “the researched,” to cultivating transformative agency from within communities, and also to preventing the filtering of historically non-dominant communities’ practices through normative epistemologies. Therefore, in Chapter 3, I characterize the design process and accompany this description with an analysis of the representation levels of the different stakeholders. However, given the study’s co-design (rather than stakeholder-led) methodology, the UCB team’s composition by non-Indigenous designers, and the particular distribution of labor that emerged in this project (UCB non-Indigenous novice designers mainly working with non-Indigenous PPN staff members), I wondered whether community participation would sufficiently represent Indigenous worldviews. Thus, Chapter 4 revolves around my non-Indigenous researcher role as a potential filter of how much of the community’s perspectives ultimately influence the evolving designs. Having considered both the design process and community representation (Chapter 3) and the changing nature of the researcher as a potential filter of Indigenous views within that process (Chapter 4), the necessity of understanding the community’s perspectives on the basic constructs of the design project became evident. Hence, in Chapter 5, I seek to understand the community’s views on wellbeing, culture, and STE(A)M fields. Chapter 6 synthesizes the findings of the previous empirical chapter through the analysis of one concrete case: a culture keeper’s description of her basketmaking practice. Below, I present a more detailed account of the contents of each chapter:

Chapter 2 | Methodology

In this chapter I present the research questions and the research methodology that have guided this dissertation. I also describe the data sources and data collection and construction processes, as well as the general data analysis procedures I used to address the research questions. Finally, I discuss my identity and positionality and how they have influenced my work.

Chapter 3 | Co-design Process and Community Representation

In this first empirical chapter, I describe the co-design process and its development over time. To create an accurate and robust depiction of the co-design process, I engaged in two cycles of synthesis. Findings are presented both as holistic yearly summaries of the partnership, grounded in key co-design events, and frequency analyses of project team communication. Given the emphasis on the inclusion of Indigenous worldviews, I emphasize joint community events—that is, events in which both Native and non-Native people participated. My intention with this detailed documentation is to address a gap in the literature about specific considerations, challenges, and opportunities in co-design projects involving novice non-Native designers/researchers working with Indigenous communities.

Chapter 4 | Shifts Experienced by a Novice Non-Indigenous Designer

In this chapter, I respond to the call for more precise articulations of the challenges that emerge in co-design and research processes (Bang & Vossoughi, 2016). I expect that turning the ‘magnifying

glass' towards myself (i.e., expanding the domain of the researched to include the researchers themselves (Bang et al., 2010; Vossoughi et al., 2016); can further highlight the reproduction of normative hierarchies in practice. Concretely, I engage in a self-reflective examination of the co-design process and my participation in it to explore how Indigenous worldviews could have gotten unintentionally filtered out of the project. While chapter 4 is reflective in nature, its analysis is empirically grounded in the data available. In the findings, I share two main shifts I experienced as a novice non-Indigenous researcher, and which impacted my conceptualization of the makerspace project. I present them departing from the assumptions that were challenged as part of the co-design process: a) STEM education promotes wellbeing; and b) A wellbeing-centered makerspace has nothing to do with Indigenous sovereignty and self-determination. Generally speaking, this chapter focuses on the analysis of dissonance between different ways of being, seeing, and making in the world for its generative potential in informing thoughtful co-design research practices more broadly.

Chapter 5 | Community Perspectives on Wellbeing and STE(A)M

While the gravitational center of the two previous chapters is the co-design process itself—approached from two different perspectives—in this empirical chapter, I analyze community perspectives around wellbeing and STE(A)M. Drawing on 21 interviews with 23 people from different tribes and one non-Indigenous person, I identify three main themes for wellbeing: a) Connectedness, balance, and spirituality, b) Cultural connection and cultural identity, c) Healing and historical trauma. I additionally identify the ways in which participants position STE(A)M relative to their historical cultural practices in ways that honor the connections without reducing one to the other. I highlight both ways in which participants identified STE(A)M education as contributing to Indigenous wellbeing as well as concerns they raised at the intersection between those two themes. I conclude this chapter by reflecting on the practical implications of the PPN community's perspectives on wellbeing and STE(A)M for the wellbeing-focused makerspace design in particular and for similar Indigenous-serving spaces more generally.

Chapter 6 | Comparison of two coding systems

This chapter presents an analytical exercise based on a single excerpted case, that of a culture keeper's basket making practice, as a microcosm for the themes, shifts, and worldviews elaborated in the previous empirical chapters. In particular, it offers a concrete example of the worldviews embedded in PPN making practices and the potential role of the researcher in either filtering them out of or facilitating their expression in a co-design process.

Chapter 7 | Conclusions

In this final chapter I summarize key findings and the contributions of this research project.

Chapter 2

Introduction

I begin this chapter by sharing a brief reflection on my identity and positionality as they shape my participation in this project and my research agenda more generally. I then lay out the research questions that guide this case study. In the next section of this chapter, I address the criteria that bound the study—the settings where the activities took place, the people who participated in the project, and the events that the PPN-UCB partnership produced and through which I pursue answers to my research questions. I then describe the methods through which data was gathered by the UCB team, the types of data collected, and finally how the extensive corpus of data was organized and analyzed. The data construction and first round of coding described below serve as the foundation for three subsequent analyses tailored to specific research questions, and which are described in Chapters 3-5.

Researcher's Identity

In a sense, the research in a qualitative study acts as the “primary data collection instrument” (J. Creswell & Creswell, 2018). Consequently, identifying personal values that implicitly shape every aspect of the qualitative research process—from choice of project and direction, to selection of data, to analysis and interpretation—is vital. In identifying my personal values and their impact on my research, I am guided by K. Gutiérrez’s (2006) *white innocence framework*. Consequently, I acknowledge that the way we, as researchers, “study cultural communities lies in the intersection of our methods, theoretical perspectives, personal and professional experiences, ideologies, beliefs, and practices, and the position of power and privilege we hold vis-à-vis the communities we study and teach.” (Gutiérrez, 2006, p. 225). Additionally, I subscribe to Peshkin’s perspective that subjectivity makes us who we are as people and researchers. Consequently, subjectivity lies at the core of the stories we can tell and can be leveraged as a strength by bringing our experiential knowledge to a conscious plane, so that it can be used as part of the research process, as opposed to giving it unrestrained freedom. (Maxwell, 2013 citing Glesne & Peshkin, 1992, p.45).

As a researcher, I bring several aspects of my identity to my research, including my personal history and my perspectives about life. To find the aspects of my identity that are tightly connected to this project and consequently might have an influence on it, I have used Peshkin’s strategy of identifying subjective “I’s” (Maxwell, 2013).

1. An *identity craving I* who believes in the importance of developing a strong sense of identity (as a non-fixed construct) and pride in who we are, while acknowledging the positive/negative effects of intergenerational legacies,
2. A *wellness seeking I* who strongly believes that the goal of life should be more about ecological flourishing and less about the accumulation of wealth,
3. A *justice-seeking I* who wants to contribute to correcting the negative and biased narratives about Indigenous communities,
4. A *non-research human I* who feels a strong connection with Indigenous communities and is grateful

to this specific community for trusting me, and for giving me the opportunity to work with them.

Other identity factors not explicitly connected to my research topic, but that also have an impact on my interactions with the community, are age, race and ethnicity, culture, socioeconomic status, educational background, accent, spoken language, personality, gender, and spirituality, among others that I may not even recognize (Crenshaw, 1989). I am a daughter, a sister, an engineer, a designer, and a researcher, among many other things. I am a 35-year-old heterosexual female born and raised in Ecuador. I was born in a middle-class family that professed Catholicism for many years. I grew up in a conservative society that inherited and internalized many prejudices from its colonizers. Racism, classism, and colorism are pervasive but not openly acknowledged or discussed. Indigenous peoples in Ecuador have experienced and continue to experience similar injustices and struggles to those faced by Indigenous populations around the world (e.g., assimilation, alienation from their native languages). I self-identify as ‘mestiza’ although many people place me under the ‘white’ umbrella given my fair skin color and green eyes—features that have given me a place of privilege, especially when I lived in Ecuador. My interest in working with Indigenous populations stems from a life-long relationship with a wonderful Indigenous woman from the Andes, Mercedes Maita. Michita, as I call her, worked for my parents as a live-in maid for more than 20 years. When I was born, she took care of me while my mom and dad worked. As years passed, I came to think of her as my ‘second mom.’ Considering and acknowledging the complexities and the asymmetric relationship between her and my biological family has been essential to my development as a human, educator, and researcher. Nevertheless, the nuances of these reflections go beyond the scope of this document and have been written elsewhere.

Researcher’s Positionality

“If you have come here to help me you are wasting your time, but if you have come because your liberation is bound up with mine, then let us work together.” - Lilla Watson

My approach to qualitative research resonates with *critical realism* (Maxwell, 2013), which subscribes to both ontological realism and epistemological social constructionism. Realism as an ontological standpoint implies that there is a real world that exists independently of human consciousness (i.e., our perceptions and theories). Social constructionism as an epistemological perspective sustains that “all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world and developed and transmitted within an essentially social context” (Crotty, 1998, p. 42). Consequently, our models, theories, and conclusions provide a limited understanding of a complex reality.¹³ In a nutshell, *critical realism* maintains that, although there is a world that exists separately from the human mind (ontological realism), it is not a world of meaning until meaning-making beings make sense of it (epistemological social constructionism).

¹³ To develop the section on my positionality I have mostly used the definitions and classification system offered by Crotty in ‘The Foundations of Social Research’ (1998). Given that I also reference Maxwell’s (2013) work, it is important to make explicit disagreements in the terminology used by the two authors. For example, what Maxwell calls ‘constructivism’ is referred to as ‘constructionism’ by Crotty. Furthermore, Crotty suggest a way of differentiating these terms by reserving “constructivism for epistemological considerations focusing exclusively on the ‘meaning-making activity of the individual mind’ and to use constructionism where the focus includes ‘the collective generation [and transmission] of meaning” (Crotty, 1998, p. 58).

Aligned with the goal of making my positionality explicit—to myself, to my peers, and to the community I work with—I also need to mention that my research project is not solely connected to my professional life. As a matter of fact, it is deeply aligned with a personal journey that started when I was a teenager and which revolves around meaning and life. Since I was 16 years old, I have gone through cycles of depression that make me reflect on what it means to live a meaningful life, and how one can pursue such a journey. Furthermore, I believe that a personal event that occurred in late 2017 (in parallel to the PPN-UCB partnership) ended up having a significant impact on the makerspace project. After my dad had a stroke in December 2017 and passed away in February 2018, I went through a long and reflective process that changed the way I am in the world and the ways I interact with it. Whereas some researchers would see personal-professional connections of this kind as a troublesome source of bias, I would like to position my background and identity as valuable components of my project. Feeling comfortable with this posture has been a long and challenging process because the theoretical perspective that permeated my formal training as an electronic engineer was (post)positivistic. When I first started to work at the intersection of engineering and education, I consistently experienced cognitive dissonance; however, engaging with this research project has facilitated a deep process of reflection and learning. Traditionally, attention and elaboration of the researcher's positionality and reflection are bounded in the methods section. In this work, I, with intention, discuss positionally throughout the dissertation, as it is fundamental to how I have made sense of the iterative design process.

Researcher's Role

Being part of the PPN-UCB partnership differed from my previous research experiences in a few ways, each of which required a period of adjustment as I came into my researcher role. Before this project, I had been part of more traditionally-structured research projects that closely followed pre-established plans, but I had never participated in a co-design project where plans needed to flexibly respond to events as the project unfolded. Though initially uncomfortable with this more responsive research approach—perhaps as a holdover from my formal engineering training—I gradually came to see it as not only permissible but as a necessary component of serving real-world communities with complex needs and hopes that cannot be uncovered and specified in a planning blueprint. My role in the project also evolved dramatically over time. Though I started as an educational designer, I soon also became an observer, a participant observer (Erickson, 2012), a facilitator, and a thought partner – in other words, a researcher. During the analytic phase of the study, I became a subject of my own research. In adopting each new role, I needed time to acknowledge, accept, and embrace the new ways of interacting with project team members and participants.

Finally, I had never engaged with Native communities from the area that is now known as the United States of America. My rather naïve understanding of Native communities herein came from media portrayals, primarily movies (Brayboy & Searle, 2007), tacitly combined with notions about Indigenous communities in Ecuador. Consequently, it took me a while to better grasp the reality and particular histories and context of the Pinoleville Pomo Nation. From the first visit to the tribal headquarters, my teammates made me aware of potential cultural differences that might affect our interactions. For example, I was told that looking people in the eye could be inappropriate. I now can acknowledge that for a long time my extreme self-consciousness—guided by my fear of unintentionally offending sensibilities—prevented me from authentically engaging with tribal members.

Research Questions

This dissertation is guided by the following research questions:

- RQ1a. How was the co-design of a culturally sensitive makerspace instantiated in practice?
- RQ2a. What shifts, if any, were triggered when the researcher encountered Indigenous worldviews during the co-design process?
- RQ2b. What factors mediated the identified shifts?
- RQ3a. What are community members' perspectives around wellbeing and STE(A)M fields?
- RQ3b. What connections, if any, do participants see between these two areas? Conversely, what tensions emerge?

Methodology: Case Study

I have chosen a case study as the methodological strategy for addressing the research questions listed above. This qualitative approach is the most appropriate for my study because of its particular relevance to exploring a real-life, contemporary, bounded system over time through detailed, in-depth data collection involving multiple sources of information (J. W. Creswell & Poth, 2018; Yin, 2006). The case under study in this dissertation is the co-design process of an *Indigenous Making Learning Ecology Centered in Wellbeing* under the context of the 2017-2019 PPN-UCB partnership. I believe that engaging in an extensive analysis of a case in which certain theoretical design sensibilities (emancipatory and political agendas (Freire, 1970; Gutiérrez, Jurow, & Vakil, 2020) encounter real-world challenges sheds light on how to improve design and research efforts in which non-Indigenous novice researchers work with Indigenous communities. In many ways, this case study includes an autoethnography, as I carefully document the onto-epistemic and axiological shifts that made this work possible. I devote the remainder of this section to explaining the parameters that bound the case.

Bounding the Case

The work in this dissertation is based on a long-standing partnership between a small Native American tribal nation in northern California, the Pinoleville Pomo Nation (PPN), and a team from the University of California, Berkeley (UCB). While the genesis of the collaboration dates back to 2007, a new cohort of graduate students, myself included, joined in 2017. Starting in 2018, the PPN and UCB joint efforts included various projects, some of them running in parallel, that can be grouped into three areas: environment (e.g., characterization of the waste stream of the tribal headquarters), housing (e.g., evaluation of the energy consumption of sustainable homes), and education and wellbeing (e.g., STE(A)M activities for the summer academy, co-design of a STE(A)M makerspace). My research interests are located within the last area and primarily revolve around the co-design of a culturally sensitive STEM makerspace, henceforth *the makerspace project*. In 2018, the makerspace project became the main design anchor of the PPN-UCB partnership after the PPN's educational director informed the UCB team that the tribe was developing a STEM Lab. The UCB team was asked to provide technological and educational assistance. As the result of conversations with the educational director, it was jointly decided that, somehow, incorporating cultural practices into the STEM Lab—reframed

as a STEM makerspace—would better suit the tribe’s aspirations to motivate youth to learn about STEM.

The corpus of data includes all the logged interactions within the general partnership as a means of acknowledging that, in one way or another, they informed the makerspace project. For this dissertation, only those interactions with direct relevance to the makerspace project are analyzed. It is worth noting that events that took place in 2017 and early 2018 are included in the analysis because, even though they pre-date the start of the makerspace project, they provide context that facilitates understanding its co-design as a holistic process. The makerspace project was truncated in 2020 due to the global pandemic (i.e., COVID-19). I attempted to keep in touch with the community through my participation in virtual workshops hosted by the PPN; however, the uncharacteristic nature of the circumstances led to an unexpected and premature end to the project.

I next describe the settings, participants, and events captured within this three-year (2017-2019) data log.

Settings

The numerous and diverse activities of the PPN-UCB makerspace project took place in a few locations in California (Figure 2.1). Nearly all of the joint face-to-face meetings took place at the PPN’s tribal headquarters, located on the lands of the Pinoleville Pomo Nation in Mendocino County, near Ukiah, CA. Workshops with children were conducted either at schools in the Ukiah Unified School District, or at the Pomo Youth Academic and Success Center located in downtown Ukiah. A few events took place in the San Francisco Bay Area, with some meetings and visits on the UC Berkeley campus and one training at Stanford University. All the ‘within’ UCB team meetings took place in Berkeley, CA – frequently on the university campus.

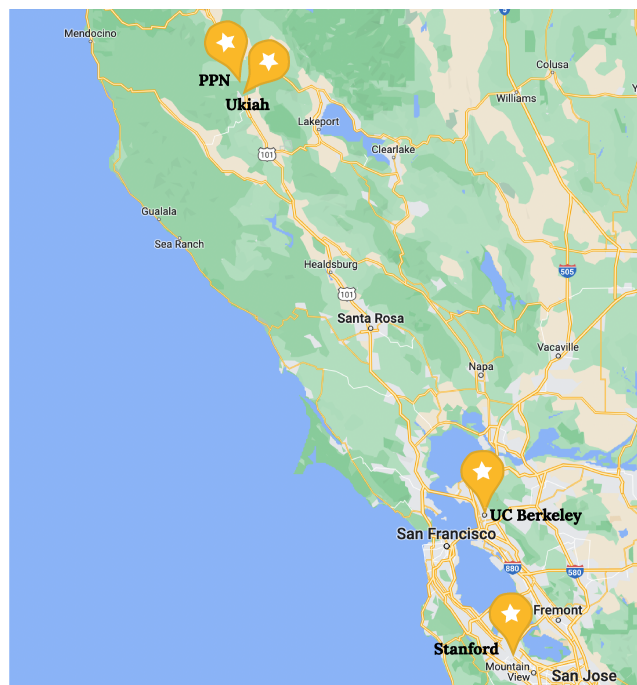


Figure 2.1. Main locations where activities related to the PPN-UCB partnership took place. *Source: Adapted from Google Maps*

Participants

While the official partnership has been between the PPN and a UCB team, this project has, in one way or another, also involved other peoples, both Native and non-Native, from what is now known as the United States of America. Consider, for instance, that not all the employees who serve in the PPN administration are PPN citizens or Native American peoples. In this new generation of the partnership, the two staff members assigned by the tribal council as our main liaisons (the educational director and the environmental director) are non-Native. Therefore, when I use the phrases ‘*the tribal council*’ or ‘*members of the tribal council*,’ I specifically refer to the elected officials of the PPN tribal government, independently of the number of members present at a given event.¹⁴ Given that citizenship in the PPN is legally defined and granted based on a blood quantum criterion,¹⁵ the phrase ‘*PPN citizens*’ particularly indicates official tribal enrollment. I use the phrase ‘the PPN’ or ‘the tribe’ (in singular) as an umbrella term to refer to a group composed of a variable number of tribal council members, PPN staff members, and/or PPN citizens.

I reserve the plurals ‘tribes’, ‘community members’, and ‘Native American peoples’ to indicate the multiplicity of Indigenous Peoples that have, directly or indirectly, influenced or been part of the project—including the PPN.¹⁶ For example, in 2019 I interviewed 23 people with heritage in 12 different tribes from California. It is worth emphasizing that although there are certainly some commonalities, tribes continue to see themselves as distinct from one another. Although the decision to use these kinds of umbrella terms inappropriately oversimplifies the cultural uniqueness and historicized experiences of the larger multi-tribal community, it acts as a thread that connects some of the shared strengths, challenges, and practices that are defined as being a part of the California Indian Community.

Events

I divide the multiple formal and informal events associated with the makerspace project into two groups: events including the PPN or Native American peoples connected to the PPN, and events that occurred without their engagement (e.g., weekly UCB team meetings, a relevant conference). Below I provide a brief summary of the main events that belong to each group. The planning communications, meeting notes, observations, reflections, and reports from these events constitute the data corpus.

Events with Tribal Participation:

Joint In-Person Meetings

Most of the joint in-person meetings were formally coordinated and scheduled by both teams and took place at the PPN’s tribal headquarters. Attendees usually included PPN staff members (both Native and non-Native), at least one member of the tribal council, and at least two members from the

¹⁴ The PPN’s web page lists five members: the chairperson, the vice chairperson, the treasurer, and two members-at-large. I interacted with the chair, vice chair, and treasurer, though usually with different individuals and/or subsets at different times.

¹⁵ Citizenship is granted when a person has “at least one-quarter degree of Pomo Indian blood” and is “related by blood to a member of the base roll” which is based upon the “Captains and Councilmen listed on the Mendocino County Indenture, dated 1878, 1893, and 1897, for the purchase of land for Pinoleville Indians” (Shelby, 2013).

¹⁶ I acknowledge that the term Native Americans refers to all Indigenous peoples from the lands that are now referred to as America (including North, Central, South America) as America (by which I mean the entire continent). However, for the purposes of this dissertation, I will use the term as bound to Indigenous peoples from what is now known as the United States of America.

UCB team. Over the three years, the size of the PPN team ranged from approximately 2-8 people. The UC Berkeley team fluctuated in size from 1-11 people, and depending on the year it could include graduate and undergraduate students, a research fellow, and/or Prof. Alice Agogino. Informal meetings were often held by phone and in person with non-Native staff members, especially with our main liaisons.

Big Time

During the three years of collaboration from 2017-2019, the team from UC Berkeley was invited to participate in some community events. One such event was the annual community gathering known as Big Time. This is a three-day event hosted by the PPN in the summer, typically between July and August. Tribal members carry on their ancestral traditions by sharing traditional foods (e.g., smoked salmon, seaweed, acorn mush), dancing, and singing. Parallel to the cultural activities, there is a booth area where PPN tribal departments, community members, or external institutions can share their work, facilitate activities for the attendees, or even sell goods. Big Time is open to the public in general and on average it attracts around 800 Native and non-Native people (Phone call notes. 2017 June 6). In 2017, the UC Berkeley team had a booth where community members could share their ideas about projects, problems, and solutions they considered important.

STEAM Summer Academy

From 2017-2019, the PPN also hosted a three-week STEAM summer camp. In this summer camp, 9-12-year-old children not only engaged with mathematics, art, and STEM hands-on activities, they also exercised, learned about their culture, and participated in other wellness-related activities (e.g., talking about historical trauma), and field trips (e.g., visiting a museum or the UC Berkeley campus). Two non-Native tutors orchestrated the experience for around 12-20 Native children from different tribes.

Maker Workshops

Three workshops were co-hosted and co-facilitated by the PPN-UCB team in 2018. These events centered around the planned makerspace and were open to the Greater Ukiah community at large. In the first workshop, participants visited different stations to learn about maker-projects, create their own projects, and provide input on what they would like to see happen in the future makerspace. The next two events focused on 3D printing and storytelling using stop-motion animation, respectively.

STEM Teaching for the 21st Century

The UC Berkeley team coordinated the participation of the tribe in the 'STEM teaching for the 21st century' training at Stanford University. Three people, a tribal council member, a non-Native staff member, and I, participated in this five-day long event thanks to the generosity of the FabLearn program. As part of the training, participants created a curricular unit relevant to their own context and presented it during the last day of the training.

Cultural Camp

The PPN also organized a three-and-a-half-day cultural camp during the summer. Culture and wellness were the two main pillars of this event that gathered roughly 30 families from different tribes. All participants had the opportunity to engage in traditional cultural practices, such as weaving baskets, making acorn mush, or playing hand games. Physical activity is promoted by offering hikes, yoga classes, and other sport sessions. Campers are also encouraged to join wellbeing workshops where issues like historical trauma, Question, Persuade, Refer (QPR, an evidence-based suicide prevention

technique), and opioid consumption are discussed. The use of technological devices is highly discouraged. The UC Berkeley team participated in the 2019 cultural camp where some of the semi-structured interviews took place. Additionally, people were invited to visit the ‘wellness booth’—a collaborative effort between the PPN Environmental department and the UC Berkeley team—and to share a word or phrase that captured what wellness/wellbeing meant to them.

Native H.O.P.E. Training (Helping Our People Endure)

In 2019 the PPN hosted a ‘Native H.O.P.E.’ training. This four-day workshop is guided by a curriculum that creates a “safe and sacred place through culture, spirituality, and humor” to “address suicide prevention, depression, trauma, violence, and substance abuse” (n.d, n.d.-b). This training prepares Native youth to assist their friends and peers through crisis situations and make referrals for support. Unexpectedly, I was invited to facilitate a few activities during the last day of the event.

Events without Tribal Participation:

UCB Team Meetings and Workshops

Starting in 2017, the UCB team held weekly or bi-weekly meetings to address issues connected to the partnership. Occasional ‘mock workshops’ took place when the team was designing and testing a community event. The majority of these events took place on campus, at the Berkeley Institute of Design (BID), and were attended by a subset of the UC Berkeley team.

Course Work and Milestones

In my months-long participation in academic courses and preparation for programmatic milestones (e.g., qualifying exams, proposal defense), I produced extensive notes, memos, diagrams, and other documents that inform the makerspace project work and my reflection on it.

Other Events

Events of other natures, such as talks (e.g., “Changing the Way We See Native America,” a discussion with photographer Matika Wilbur), conferences (e.g., Tribal EPA Region 9 Conference), or visits to museums (e.g., the National Museum of the American Indian) that had a connection to the makerspace project (or the more general collaboration) have also been included.

Data Collection

While multiple data gathering methods were used by the UCB team throughout the co-design process (May 2017 - December 2019), the three primary methods were: a) participant observation, b) semi-structured interviews, and c) gathering of artifacts, documents, and communication records (e.g., e-mails, phone call notes).

Participant Observation

The types of data generated and collected through participant observation during the events mentioned above include field notes created by one or more members of the UC Berkeley team (normally the graduate students), qualitative documents (e.g., meeting agendas and minutes, artifacts

created by the community), and qualitative audiovisual and digital material (e.g., photographs).¹⁷

Semi-structured Interviews

In 2019 I conducted 21 semi-structured interviews with 24 participants. All of them were somehow connected to the PPN, be it as citizens, as administrative staff or their relatives, or as participants in the tribe's activities. Elders, adults, and teenagers were represented, and 62% of the participants were women (Table 2.1). (See chapter 5 for more details.)

Table 2.1. Semi-structured interview participants

	Elders [+60 years-old]		Adults [18 - 60 years-old]		Children [10 - 17 years-old]		TOTAL
	F	M	F	M	F	M	
Native American peoples	3	1	8	5	3	3	23
Non-Native American peoples	0	0	0	1	0	0	1
TOTAL	3	1	8	6	3	3	24
	4		14		6		

PPN administrative staff and the larger Native community were invited to participate via emailed and posted flyers and through one-on-one contact by the education liaison and me. Recruitment continued until teenagers, adults, and Elders were represented. Respondents' time was acknowledged with a gift card to an online retailer, with a value of \$30 for teens and adults and \$50 for Elders. The interview protocol was first tested with an adult community member, and, based on this experience, questions were re-ordered in line with desired emphasis. This test interview is not considered part of the data corpus. Interviews lasted an average of 67 minutes with a minimum of 30 minutes and a maximum of 90 minutes. I conducted all the interviews, and they took place wherever the interviewee chose (e.g., their home, the PPN headquarters, over the phone). I started each session by explaining the interview procedure, securing consent—and assent in the case of minors—and assuring participants that they could stop the interview at any time. The session was audio recorded or video recorded according to interviewee preference. The first set of questions was designed to help build rapport between participants and the interviewer and to frame the session as a conversation. Participants were then asked a variety of questions to elicit their perspectives around wellbeing, its potential connection to their culture, and STE(A)M fields. For the full semi-structured interview protocol, please see Appendix 2A. Recordings totaling 1434 minutes (23 hours and 54 minutes) were transcribed: 1117 minutes by me and 317 minutes by a transcription service.¹⁸

Other Communication Records

I collected all communication events related to the project in which I was a participant.¹⁹ The corpus of data includes a) numerous email threads exchanged within the UCB team and between the PPN

¹⁷ All data collected was protected as required by the corresponding IRB protocol. All records have been secured on a password-protected computer.

¹⁸ I reviewed the transcripts generated by the service to ensure accuracy.

¹⁹ I did not have access to communications strictly within the PPN team. In a similar fashion, I had no access to

and UCB team members, b) available notes of phone calls between the teams, and, c) a few text messages exchanged within the UCB team and between the teams.

Data Construction and Analysis

The nature of the research questions paired with this extensive and diverse corpus of data required a data construction technique that preserved “the historical chronological flow,” allowed a “good look at what led to what, and when” (Miles & Huberman, 1994b, p. 110), and supported the simultaneous visualization of different media records (e.g., field notes, photographs, posters). Achieving such a data construction with the project’s vast amount of data required a few iterations.

First, to visualize the whole process at a glance, I created a qualitative timeline (Miles, Huberman, & Saldaña, 2020) of the three-year design process. I made an initial small-scale and ‘low resolution’ display that included only key meetings, communications, and events with the tribe (Figure 2.2).

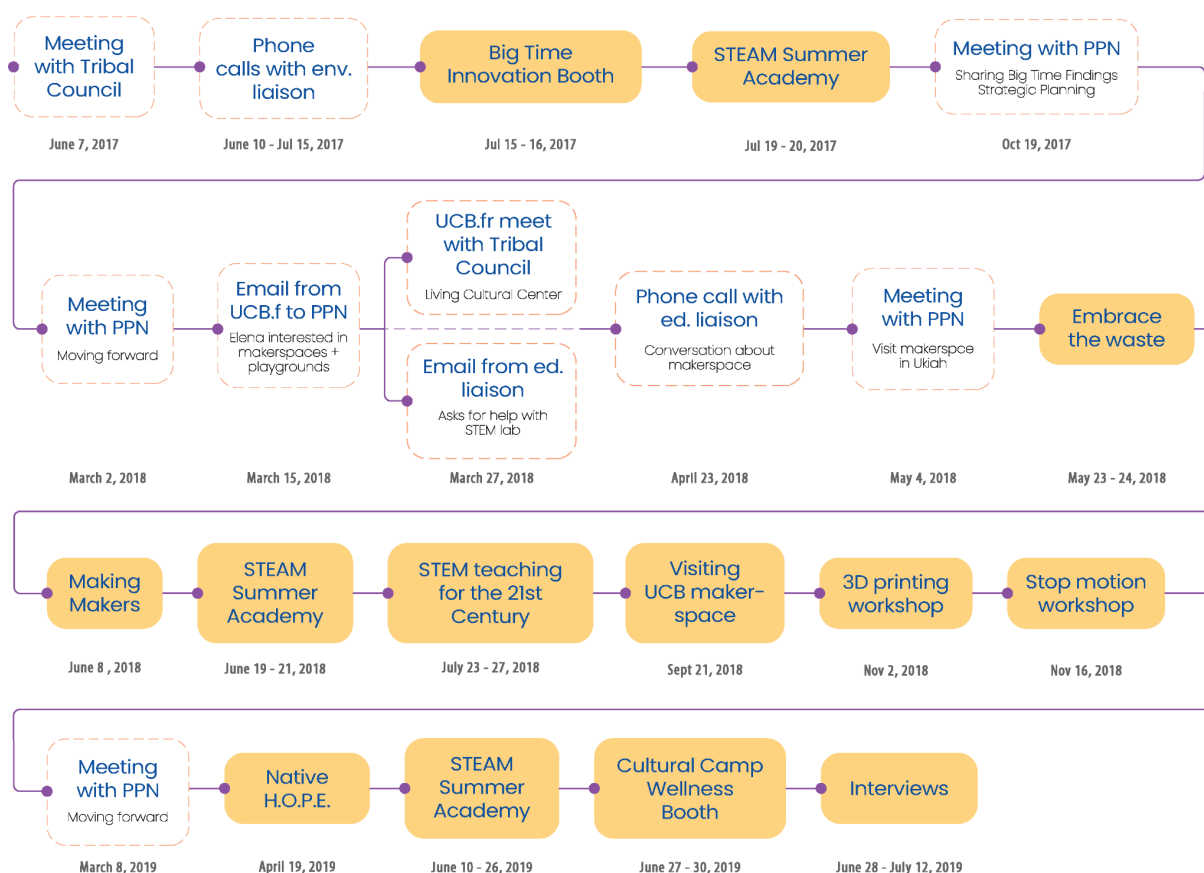


Figure 2.2. Initial small-scale, ‘low resolution’ timeline of the design process

This proved inadequate to address the research questions but served as a springboard for creating a larger scale, ‘high resolution’ timeline (Figure 2.3). To guarantee the accurate chronological depiction of events, I also conducted a comprehensive review of available communication records (see the ‘Other Communication Records’ section above for more details), field notes, and calendar events.

communications that might have occurred exclusively between another member of the UCB team and the community.

This careful examination also enabled me to reconstruct a “play by play” of events, processes, conversations, and communications that might otherwise be overlooked or oversimplified. Finally, I reorganized elements in the timeline and added some layers to it to distinguish:

- Co-design events (e.g., meetings, workshops) along with their corresponding physical artifacts (i.e., agendas, drawings, posters, field notes)
- Academic and design events in which I participated, and which, although initially considered as liminal, impacted the project deeply (e.g., participation in UC Berkeley courses, visits to museums, conferences and talks by Native American peoples)
- Small and large scale events that affected the people involved in the project (i.e., domestic calamities, fires in California, and the pandemic)
- People who, directly or indirectly, had an impact on the project (i.e., Native and non-Native, directly connected to the project or not).



Figure 2.3. High resolution’ timeline of the design process

Second, departing from the ‘high resolution’ timeline, I created a semester-by-semester comprehensive design log using a word processor. The main goal of this design log was to gather in one place as much of the corpus of data as possible (e.g., email threads, tribal documents, field notes, reflections, memos, meetings agendas, artifacts created in co-design workshops, diagrams, etc.). If a specific media file or resource could not be included in the design log, its respective link was included instead (Figure 2.4).

Summer 2017	43
Work	43
GSR Kimiko - LAUGHTER	43
Barbara White Geometris	43
PPN Project	43
IN-PERSON MEETING 2x NA, PPN, sf + 3xUCB.g + 2xPPN.c Zack, Zhao, Pierce, George, Elena, Leona, Angela (at least) First in person meeting. Interest in wellness, educational activities, and inFEWS June 7th, 2017	43
Summary	43
Details	43
EMAIL THREAD A3 1xNA, PPN, sf + 3xUCB.s + 3xUCB.g + 3xPPN.c Support letter for PPN Community wellness From Zhao to Alice CC: Angela, Pierce, Yael, Lenora, Elena, George, Leona, Laura Jun 7th to Jun 13th, 2017	44
EMAIL Email A3 pdf	44
TRIBAL FILE Community wellness project abstract photo	44
Summary	44
Details	44
Attachment content - PPN Community Wellness Project Abstract	45
SOCIAL EVENT 3xUCB.g + 1xNA, PPN, sf + 1 extra Pierce + George + Elena + Zhao + John Lunch at the Jyun Kang Restaurant June 7th, 2017	45
Summary	45
UCB-MEETING 3xUCB.g Pierce, George, Elena Prep for the Big Time Innovation workshop various	46
UCB FILE Pierce's memo google doc June 16th, 2017	46
UCB FILE George's design notes google doc June 30th 2017	46
EXTERNAL FILE Cooper Hewitt museum of Design video and photos June 16-17th 2017	46
Summary	46
Details	46
Attachment Content - Pierce's memo	46
EMAIL G 1xUCB.s + 2xUCB.s + 4xUCB.g + 3xPPN.c Design innovation workshop G: From Pierce to Zack and D4: From Elena to Zhao CC: Alice, George, Elena, Deniz, Lenora, Leona, Angela, Pierce Jun 9th - June 17th	48

IN-PERSON MEETING | 2x NA, PPN, sf + 3xUCB.g + 2xPPN.c | Zack, Zhao, Pierce, George, Elena, Leona, Angela (at least) | First in person meeting. Interest in wellness, educational activities, and inFEWS | June 7th, 2017

Summary

In order to identify projects that shared interests between UCB and the tribal council, it was decided that UCB will participate in Big Time (a main cultural event). From this first meeting the UCB team learned that PPN is interested in wellness, educational activities, and inFEWS.

Details

During this meeting Pierce introduced the new members of the UC Berkeley team (George and Elena) and the areas that through phone and in-person meetings with the tribal council and staff members, it was agreed that to further determine projects that aligned with both of our interests was through our participation in one of the main annual cultural events of the tribe, their Big Time.

First question the team was asked was something connected to how we are going to give back to our own communities. It was Leona who asked this question. (Do we have notes?)

We learned the general interests and concerns of the community. For example, the PPN was critically interested in focusing on the topics of wellness, indigenous knowledge systems, and climate change adaptation, among other issues. However, to learn about specific projects around which research can be focused, required further input from the larger Pomo community. As a result, we decided to host a facilitative innovation workshop at one of their biggest annual cultural activities: Big Time. Zhao and Zack (both non-native) were assigned as our main contacts to move forward. Zhao for the educational activities and Zack for the Big Time innovation workshop 2017.

As a result of the first in person meeting, UC Berkeley agreed to give a support letter to the PPN so they can get a wellness grant.

EMAIL THREAD A3 | 1xNA, PPN, sf + 3xUCB.s + 3xUCB.g + 3xPPN.c | Support letter for PPN Community wellness | From Zhao to Alice | CC: Angela, Pierce, Yael, Lenora, Elena, George, Leona, Laura | Jun 7th to Jun 13th, 2017

EMAIL | Email A3 | pdf

Link [here](#)

TRIBAL FILE | Community wellness project abstract | photo

Link [here](#)

UCB FILE | Grant support from UC Berkeley | pdf

Link [here](#)

Summary

The first meeting with the tribal council resulted in a draft of a support letter for the PPN Community Wellness project + abstract. The letter was signed by Alice and supports PPN obtaining a 2017 Social and Economic Development Strategies (SEDS) Grant. It includes an outline of the commitments signed by Alice.

Details

Zhao wrote to Alice on Wed, Jun 7, 2017 at 10:07 PM "We had such a productive and fruitful meeting today! Attached is the draft support letter for PPN Community Wellness Project and a project abstract.

Figure 2.4. Screenshots of the Comprehensive Design Log

Data Reduction and Analysis

Once the word processor proved insufficient to manage the amount of information in the comprehensive design log, I decided to migrate the data to a specialized software for data analysis, MaxQDA. All the events and communications, along with the actual content of the message/meeting minutes/etc., and respective attachments, were imported and organized in MaxQDA, resulting in 947 records. The bulkiness of the data lead to the creation of a system of organization for the files (Figure 2.5) with the following six types:

Occurrences

These include written communications (emails, text messages), phone calls, face-to-face interactions (face-to-face meetings, workshops, and gatherings), and other events. In cases where one of the occurrences did not have a document linked to it (e.g., a phone call without notes), I created a MaxQDA document for it.

UCB Files

Agendas, planning documents, materials created by the UCB team for occurrences/events (flyers, prompts, posters, etc.), project descriptions, proposals, researchers' memo's, debriefing reports, reflections, field notes, etc.

Tribal Files

Files created by and/or shared by the tribal community (more concretely the PPN). The file name should capture the date of creation; however, the date (variable) should reflect the date on which the file was shared with the UCB team

Artifacts	These are artifacts created as the result of people participating in an event/activity (e.g., storyboards, feedback notes, posters, wellbeing cards, etc.). I have included photos of people participating in occurrences/events in this folder.
External Files	These include any other files linked to an occurrence that, although they did not lie at the heart of the collaboration with the PPN, had an impact on the project (e.g., photographs of visits to museums, videos of talks, conference programs, etc.).
Diagrams	These include photographs of diagrams that convey conceptual information around the collaboration. These diagrams were created either by the UCB team or in a collaborative effort between teams.

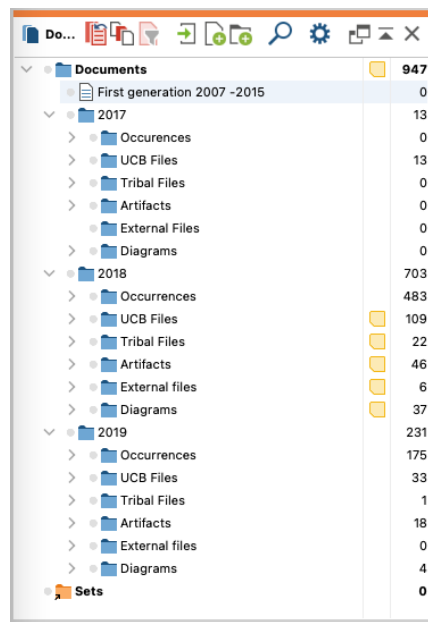


Figure 2.5. MaxQDA

File organization was constrained by MaxQDA limitations, namely that it only allows two levels of folders. All files are chronologically organized within their respective folders.

Departing from the *document system organization* explained above, each document within the folders labeled as <Occurrences> was timestamped and coded in terms of the categories in Table 2.2 (emails, text messages, phone calls, etc.) The actual content of the message/meeting minutes/etc., along with any other relevant attachment, were also stored in the database along with each record for future qualitative analysis. In a subsequent coding phase, all occurrences that were linked to the makerspace project were flagged. Occurrences in 2017 and early 2018 were considered as relevant because, even though they pre-date the actual start of the makerspace project, they provide context for understanding its co-design more holistically.

Table 2.2. Types of occurrences along with their codes

Type of occurrence	Code	Details
Email	EMAIL	All the emails available [to me] were included, regardless of their length, duration, or whether they received a response or not.
Text message	TEXT	All text messages that were logged in some way (e.g., mentioned in an email or field notes) were included. Given the nature of this kind of occurrence (one-to-one informal communication) their availability is scarce.
Phone call	PHONE.CALL	All phone calls that were logged in some way (e.g., calendar events, mentioned in an email, or field notes) were included. However, some did not have notes associated with them. Their duration varied from a few minutes to almost an hour. (Call duration was not logged.)
Face-to-face meeting	F2F.MEETING	All face-to-face meetings that were logged in some way (e.g., calendar event, mentioned in an email) were included. Some did not have notes associated with them. These meetings ranged from 1-4 hours. Note: Interviews were coded as F2F.meetings.
Face-to-face workshop	F2F.WORKSHOP	Face-to-face workshops, in comparison to Face-to-Face meetings, involved active participation outside the PPN-UCB team. Attendees engaged in previously planned activities, and workshops lasted 1-3 hours.
Face-to-face gathering	F2F.GATHERING	Face-to-face gatherings were socio-cultural events where people interacted with each other more casually. For example, a 1.5-hour lunch or a 3-day-long camp.
Other	OTHER	Occurrences coded as 'other' generally were events organized by an external entity (i.e., other than the UCB team or PPN). Some examples include talks given by Native American peoples, conferences, etc.

All three empirical chapters make use of the previously described data construction and analysis, and henceforth I will refer to it as the MaxQDA dataset. However, each one of them required specific data analysis to address its corresponding research question(s).

Chapter 3: Co-design Process and Community Representation

In chapter three, I describe the co-design process and its development over time. Using the above MaxQDA project as a starting point, I present the makerspace project work both through a quantitative analysis of the nature of the exchanges between the teams (i.e., frequency analysis of inter- and intra-team communications) and proportions of team representation, and in holistic annual summaries that emphasize co-design events with community participation. This blend of analytic techniques captures the felt sense of how the makerspace project evolved overtime—its changing goals, priorities, and practices—as well as a quantitative reflection of that evolution.

Chapter 4: Shifts Experienced by a Novice Non-Indigenous Designer

In this second empirical chapter, I use the co-design events identified in Chapter 3 to further my understanding of the research process through self-reflective examination of the co-design process and my participation in it. In particular, I investigate how Native worldviews might get unintentionally filtered out by novice designers who aim to work with and serve Native communities. While this chapter is reflective in nature, its analysis is empirically grounded in the MaxQDA project data. Building from the *high-resolution timeline* mentioned above, I identified events where I felt dissonance and used events as anchors to examine shifts in my conceptualization of the project. If the dissonance was confirmed, after examining the relevant events in the MaxQDA project, the respective event was labeled as a *critical incident* (Miles & Huberman, 1994a). For each *critical incident* I re-analyzed the pertinent documents to determine whether it might have been linked to the filtering of community

worldviews.

Chapter 5: Community Perspectives on Wellbeing and STE(A)M

The final empirical chapter responds to the shifts identified in Chapter 4 by seeking to better understand the community's perspectives around wellbeing, STE(A)M fields, and their intersections. Findings are based on the 21 semi-structured interviews I conducted with a sample of 24 individuals. Cleaning, coding, and analysis were completed using MaxQDA. Interview transcripts were analyzed with a dual-pass coding technique (Saldaña, 2021). Transcripts were first coded along the major themes derived from the interview guide. In the second pass, data coded segments of the first pass were analyzed for patterns across participants.

Limitations

The exploratory nature of the PPN-UCB partnership limited the types of data that could be collected, as is expected in this type of project. Although it is highly relevant and desirable to perform holistic analysis that includes the perspectives of all stakeholders (e.g., tribal members, non-Native staff members, faculty and graduate students from UC Berkeley), unfortunately the data corpus does not include PPN's internal occurrences nor reflections on the design process. Similarly, it does not include either potential communications between high-level members of the PPN and UCB teams (e.g., between Prof. Agogino and PPN leaders) or informal communications (e.g., text messages, post-meeting chats) between project team members in which I was not a participant. Using a dataset of this nature to analyze the co-design process as a whole is a limitation that could, and should, be addressed in future work. Similarly, the analysis of the process has been performed only from my perspective. This is another limitation that needs to be considered in future research.

Additionally, in 2020, the COVID-19 pandemic prematurely upended all plans linked to the makerspace project. Events and meetings were either canceled or moved online. In April 2020 I caught COVID-19 and was out sick for about a month. I continued to participate in a few online events, but as the world descended into unprecedented chaos and uncertainty, later in the year it became clear that it would be very difficult to conduct further work with the community, and the distance slowly weakened the connections I had created with them. Local interviews, workshops, and the work of building the proposed learning environment would remain unsafe for a long time. Towards the end of 2020, as the COVID-19 vaccines started to be rolled out, I realized that it would be unfeasible to conduct further data collection or start space design and construction. A decision was made then to conclude data collection, re-scope the research questions, and focus on the process of design rather than on the (now impossible) outcome of designing a space with the community.

Summary

I began this chapter by introducing the research questions that guide this dissertation. I then shared a reflection on how my identity as a mestiza woman and engineer from Ecuador, as well as my positionality as a researcher, designer, and educator shape both my participation in this project and my research agenda. Specifically, this reflection highlights the challenges I experienced as a formally-trained electronics engineer in considering other ways of being, acting, and making in the world. Next, I detailed my research approach, and in particular, my choice of a case study methodology. This analytic approach is a particularly good fit for this study given its scale, temporality, and contemporary

real-life nature. I bounded this study to consider activities of the PPN-UCB collaboration that occurred mainly between 2017 and 2019. These activities involved both in-person and remote communications within the UCB team, between the UCB and PPN teams, and between both teams and the broader PPN community. Data collection resulted in an extensive corpus of emails, meeting notes, field observations, documents, proposals, and interviews, all of which were chronologically organized using a software devoted to qualitative data analysis (i.e., MaxQDA). The resulting MaxQDA dataset served as the foundation for three subsequent analyses tailored to specific research questions as they will be addressed in the remainder of this dissertation, as described in Chapters 3-6. The remainder of this dissertation will proceed as follows. Chapter 3 will use both frequency analysis and holistic annual summaries to document how the co-design of a culturally sensitive makerspace occurred in practice (RQ1). Next, Chapter 4 will use chronological sequencing to identify shifts (RQ2a) and associated mediators (RQ2b) that arose between the researcher's and Native American worldviews through self-reflective identification of critical incidents in the project's trajectory. Chapter 5 will use dual-pass coding on 21 semi-structured interviews to identify community members' perceptions of wellbeing, STE(A)M (RQ3a), and any potential connections between the two (RQ3b). Finally, Chapter 6 will exemplify and synthesize the findings of Chapters 3-5 through the case of a culture keeper's description of her basketmaking practice.

Chapter 3

Introduction

In this chapter, I explain that, while the flexibility of the definition of co-design as a design approach allows for co-design processes to be suitable to various realities and contexts, it also might jeopardize accountability and the creation of a coherent body of knowledge. While the field of Indigenous making and sharing is burgeoning (Barajas-López & Bang, 2018a, 2018b; Hamilton & Morgan, 2022; Tzou et al., 2019), there is a lack of research literature that delves into co-design processes themselves. Consequently, by providing a detailed account of the co-design process of the PPN makerspace project, combining qualitative descriptions with a novel data logging and analysis method, I expect to contribute to a body of literature that informs a more robust theorization of co-design as a design approach that can guide collaborative projects with non-dominant communities.

I start by explaining the necessity of providing a descriptive and precise account of the co-design process of the PPN makerspace project. Then I share the specific research question that guided reflections on this co-design process and the analytic strategies that allowed me to answer that question. As findings, I provide yearly summaries of the co-design process as well as quantitative analysis of the exchanges between the teams and proportions of team representation. This blend of analytic techniques captures both the felt sense of how the makerspace project evolved over time—its changing goals, priorities, and practices—as well as a quantitative reflection of that evolution. The implications of these findings for the research and development process are then discussed. This general understanding of the co-design process lays the foundation for the findings presented in the next three empirical chapters.

Background

Co-design has become a popular approach in several academic and practice-based communities. It is traditionally located under the umbrella of Participatory Design (PD), the practice of design that includes stakeholders as participants. Depending on the mode of participant engagement, PD practices can fall on a spectrum from user-centered design to user-led design; with co-design in between the extremes (Brubaker et al., 2017). Steen (2012) refers to co-design as a practice that is characterized by the engagement of the ‘stakeholders’ throughout the design process activities. The nature of this definition allows for multiple interpretations, and therefore, practical instantiations. On one hand, this flexibility allows for co-design processes to be suitable to various realities and contexts. On the other hand, as Hayward (2004) suggests, it might jeopardize accountability and the creation of a coherent body of knowledge.

While matters around flexibility and accountability are relevant to co-design processes in general, they acquire special significance when two groups of historically different cultural and socio-economic standing decide to work together. Indigenous scholars, for instance, advocate for design practices that disrupt historically shaped inequities and cultivate transformative agency from within communities (Bang & Vossoughi, 2016). Furthermore, they emphasize that strengthening co-design collaborations requires shifting power and authority away from researchers and designers to position community members as experts of the relevant socio-cultural and historical complexities (Bang &

Vossoughi, 2016; Gutiérrez et al., 2020). While researchers in different fields (e.g., Development Engineering, Learning Sciences) subscribe more and more to the kind of design sensibilities mentioned above, the diversity within and between communities introduces a high variability in real-life co-design processes (Harrington, Erete, & Piper, 2019). Thus, when a non-dominant community and an elite university decide to establish a co-design partnership, issues around worldview differences, power dynamics, and systemic inequalities should be considered with particular care.

With these considerations in mind, it follows that we cannot assume that all projects guided by co-design approaches and inspired by emancipatory agendas succeed in engaging all stakeholders in a meaningful way as co-participants. Furthermore, in some cases such symmetry might not be realistic or even desirable. For example, Hayward (2004) claims that non-participation and peripheral participation are valid and legitimate choices exercised by community members. Indeed, the lack of research literature on co-design processes with Indigenous communities points to the paucity of resources to inform such work. Thus, work remains to portray multiple possible real-world scenarios for co-design processes between non-dominant communities and university teams embedded in Western practices and structures. I posit that such understanding will contribute to a more robust theory about co-design as a design approach.

Research Question

The research question guiding this chapter is: How was the co-design of a culturally sensitive makerspace instantiated in practice? (RQ1a)

Data Analysis

Chapter 2 outlined how the PPN-UCB partnership included multiple projects, and how my work in this dissertation is primarily bounded to one of them, the *makerspace project*. The analysis presented in this chapter builds on the MaxQDA dataset described in Chapter 2. That is, the corpus of data for this analysis was already organized, and I had already completed a first round of coding to identify types of occurrences and to flag makerspace-relevant occurrences.

So as to answer the research question in a way that would not neglect the nuances of the process, and given the magnitude of data sources involved, I divided each year into three periods using the main co-design events as the boundaries (i.e., the Big Time Innovation Booth for 2017; the Makerspace Grand opening for 2018; and Living in Ukiah for 2019). That is, I defined a *before* the event period, a *during* the event period, and an *after* the event period.

I then developed a particular form of logging, categorizing, and quantifying all occurrences (i.e., emails, phone calls, meetings) and their corresponding documents (e.g., field notes, phone call notes, meeting agendas and notes) for each period, and created a detailed account thereof. The level of detail—a consequence of attempting to capture design moves, interactions between teams, and representation—resulted in an exhaustively extensive log. Therefore, I completed a second round of synthesis, which generated a holistic yearly summary of the co-design partnership. I especially emphasize joint co-design events (i.e., events in which both Native and non-Native people participated).

To quantify the nature of the exchanges between the teams and team representation, I also used the MaxQDA dataset. Each occurrence was then coded according to the nature of the exchange as within or between teams (see Table 3.1) as well as the team and sub-team represented (e.g., Tribal Council members, UCB non-Native graduate students; see Table 3.2). For each event, the number of

team members who were represented was also recorded.²⁰

Table 3.1. Nature of exchange assigned to each occurrence along with their codes

Nature of the exchange	Definition	Code
Intra UCB team	Exchanges within the UCB team (i.e., any occurrence with the exclusive participation of members from the UCB team)	Intra UCB
Inter PPN-UCB	Exchanges between the PPN team and/or community and the UCB team (i.e., any occurrence where there was at least one member from each team/community).	Inter PPN-UCB

Table 3.2. Codes and subcodes for the PPN and UCB teams and their respective members

Team	Code	Sub-team	Sub-Code
PPN Team (the whole team, suffix .t)	PPN.t	PPN tribal council member(s) (suffix “.c”)	PPN.c
		PPN staff member(s) – Native American (.NA)	PPN.NA
		PPN staff member(s) – Non-Native American (.nNA)	PPN.nNA
UCB Team (the whole team, suffix .t)	UCB.t	UCB faculty/researchers (.fr) – Non-Native American	UCB.nNA.fr
		UCB graduate students(s) (.g) – Non-Native American	UCB.nNA.g
		UCB undergraduate student(s) (.u) – Non-Native American	UCB.nNA.u
Other	Oth	Other Native American peoples from the community (from PPN or any other tribe from the area) (.oth)	PPN.NA.oth
		Other PPN staff member(s) – Non-Native American (.nNA)	PPN.nNA.oth
		Other person(s) with a UCB affiliation - Native American (.NA.oth)	UCB.NA.oth
		Other person(s) with a UCB affiliation – Non-Native American (.nNA.oth)	UCB.nNA.oth
		People that had no affiliation with the PPN or UCB – Native American	EXT.NA.oth
		People that had no affiliation with the PPN or UCB – Non-Native American	EXT.nNA.oth

²⁰ For the purposes of this dissertation, representation is strictly related to the *physical or virtual presence* of a team, team member, or other people in an occurrence. For example, if someone was included in an email thread, this person was counted as being represented in it independently of whether he/she/they actually replied to the thread.

To better capture each team’s “proportion” of representation, data linked to team and sub-team representation has been normalized. The proportion of representation of a given team is conveyed as a percentage of the team’s full size.²¹ For example, to analyze the average distribution of representation per team (i.e., UCB.t and PPN.t) for inter-team occurrences (i.e., what percentage of each team was represented in inter-team occurrences, on average) for a certain period of time, I first filtered all inter-team occurrences to the chosen time-range. Then, for each occurrence, I calculated the number of representatives per team who were part of that given occurrence. To calculate the representation percentage, I divided the number of representatives per team in a given occurrence by the corresponding team’s full size (see Appendix 3A1). Finally, I averaged this percentage of representation per occurrence for all occurrences in the given time range. Consider the following example:

- 1) For one period in 2017, there were five inter-team occurrences (three email threads, one face-to-face gathering, and one face-to-face meeting).
- 2) Table 3.3 shows the total representatives per team per occurrence.
- 3) To calculate each team’s representation percentage, I divided the number of representatives by the corresponding team’s full size using the normalization table in Appendix 3A, and then averaged representation across all occurrences. In this case, UCB’s representation was 76% and PPN’s was 40% (see Table 3.3).

Table 3.3. Example of occurrences for in May and June 2017

Document name	Occurrence	UCB.t	PPN.c	UCB.t%	PPN.t%
2017 May 17-22. EMAIL THREAD A1	EMAIL	3	1	60%	13%
2017 May 17 - Jun 6. EMAIL THREAD A2	EMAIL	5	4	100%	50%
2017 Jun 7. JOINT MEETING. 1st PPN	F2F.MEETING	3	6	60%	75%
2017 Jun 7. EMAIL THREAD A3	EMAIL	5	4	100%	50%
2017 Jun 7. SOCIAL. Restaurant	F2F.GATHERING	3	1	60%	13%
AVERAGE				76%	40%

The same procedure was applied to calculate the representation percentages for each sub-team. However, this logic cannot be used to depict the general representation of community members because there is no reference with which to normalize the data.

Limitations

The quantification of team representation helps to get a valuable high-level sense of the co-design process in terms of the interactions between the teams; however, it does not provide a nuanced perspective on the quality or nature of the exchanges. I have—partially—addressed this limitation by providing a qualitative account of the main co-design events. While the corpus of available data allows for a more in-depth analysis of the quality of exchanges (e.g., a full-blown analysis of participation in

²¹ This normalization process does consider that the full team size and sub-team size varied from semester to semester. However, it assumes that all members of both teams were supposed to attend all occurrences, which does not mirror the reality of the design process.

emails threads), this kind of exploration goes beyond the scope of this dissertation.

Findings

2017 | Defining Areas of Interest for the Design Collaboration

Chronological Summary of the Co-design Process in 2017

In 2017, through the exchange of emails, an innovation workshop, and face-to-face meetings, the PPN team and UCB team scoped the design partnership. At the first face-to-face meeting, the three initial areas of collaboration (i.e., food, energy, and water systems) were jointly extended to five (food, energy, water systems, education, and wellbeing), and the tribe assigned two non-Native staff members—their Environmental Director and their Educational Director—to act as our main liaisons. Using the above-mentioned general areas as a departing point, the teams planned to further identify concerns and perspectives important to the Native Community from the greater Ukiah Area. Concretely, the UCB team was offered the opportunity to facilitate a community-targeted activity at one of the tribe’s main cultural events, their Big Time. In an *Innovation Booth*, attendees were invited to share what problems they thought should be addressed by the PPN-UCB partnership, what solutions it should consider, and what success therein would look like. The UCB team was also invited to facilitate an activity at the tribe’s STEAM Summer Academy. During two separate sessions, children were invited to think about problems connected to the five previously mentioned areas and to use robotics to create a prototype for their proposed solution. During Fall 2017, the UCB team analyzed the data from the Innovation Booth (i.e., half-sheets with community thoughts) and then shared the results with the tribe during the October 20th in-person joint meeting. The remainder of the year was devoted to narrowing down concrete possibilities of collaboration for 2019. Throughout the year, the intra-UCB occurrences outnumbered the inter-PPN-UCB ones (Figure 3.1), largely due to the bi-weekly meetings that the UCB team held throughout the year (Figure 3.2).

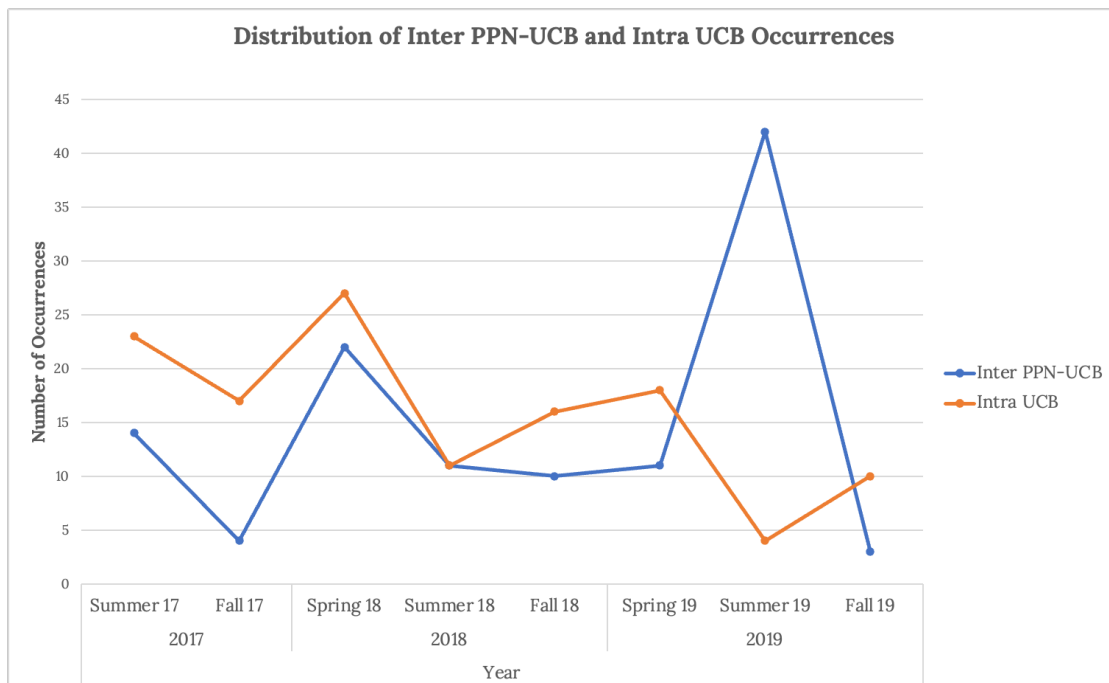


Figure 3.1. Distribution of inter-PPN-UCB and intra-UCB occurrences

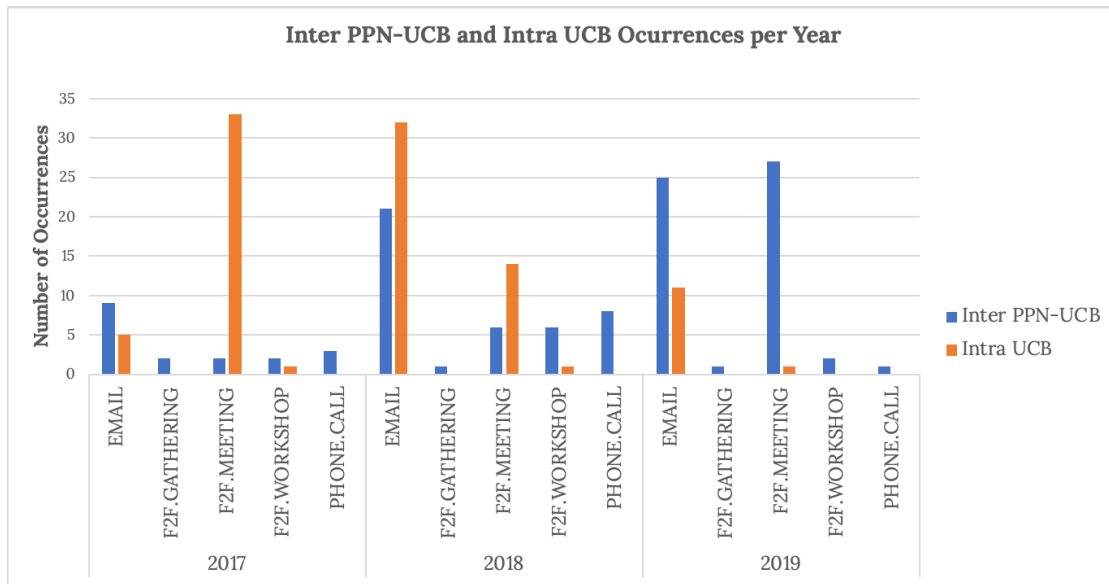


Figure 3.2. Distribution of types of inter-PPN-UCB occurrences per year

When analyzing sub-team representation in inter PPN-UCB occurrences (Figure 3.3 left) the average representation of the non-Native UCB graduate students and faculty/researchers, along with non-Native PPN staff members (Figure 3.3, left, orange and light blue) was higher than that of the PPN council and Native PPN staff members (Figure 3.3 left, dark blue and yellow). The potential implications of this distribution of labor where non-Native peoples' rates of representation are considerably higher than representation rates of Native peoples can have repercussions for the representation of Indigenous perspectives. This issue will be further addressed in the discussion section toward the end of this chapter.

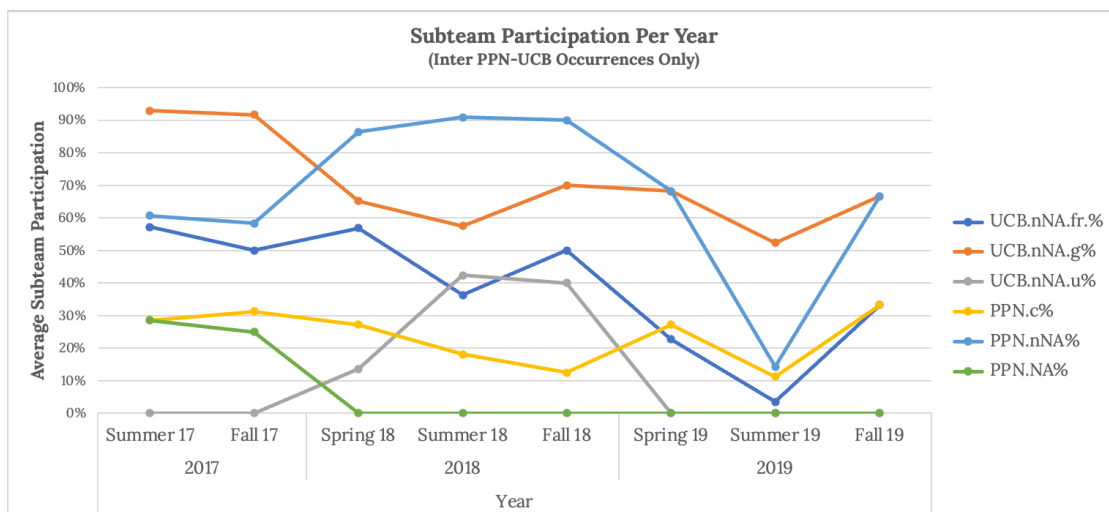


Figure 3.3. Distribution of average subteam representation per year

Though not normalizable in the same way as team and subteam representation, participation by other PPN community members, UCB communities, and external people is tracked in aggregate across face-to-face workshops and interview events (Figure 3.4, left). For 2017, the Big Time Innovation Booth

engaged almost 30 community members while the Summer STEAM workshop engaged about 12 Native youth (Figure 3.4 left, yellow).

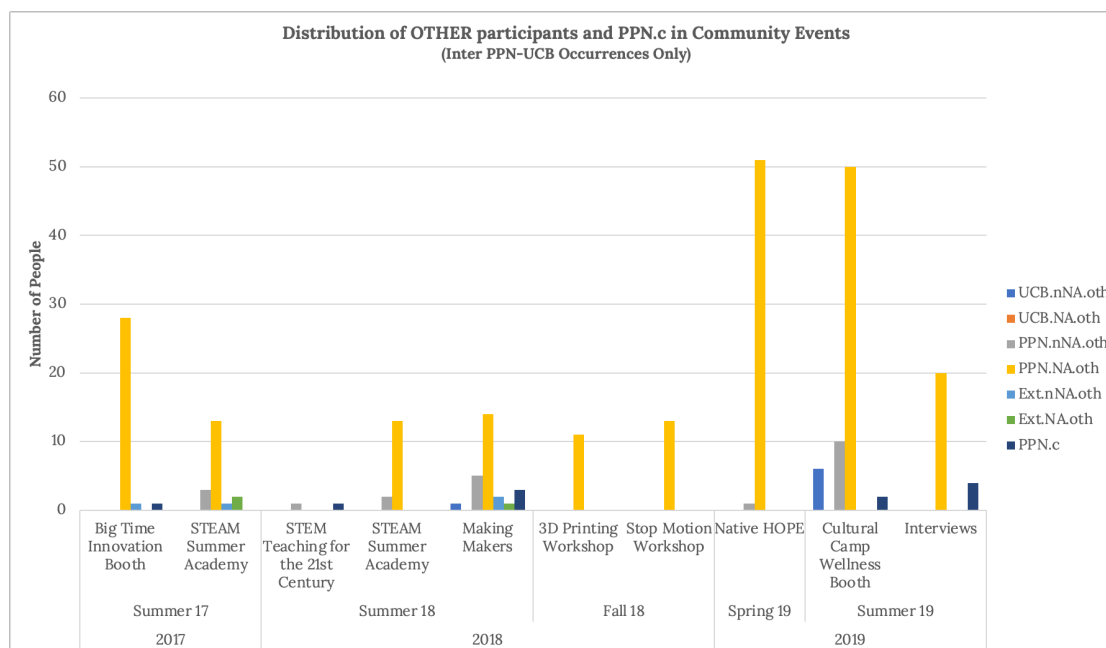


Figure 3.4. Participation of community members in face-to-face workshops and interviews

Events

Big Time Innovation Booth

Ukiah | July 15th, 2017

The Innovation Booth took place during the second day of the PPN’s Big Time, a yearly cultural event hosted by the PPN. During this three-day gathering, Native and non-Native peoples celebrate ancestral traditions by sharing traditional foods, dancing, and singing. (For a more detailed explanation of the event, please refer to the data collection section in Chapter 2.) The Innovation Booth, designed and facilitated by the UCB team, had two components. The first one was aimed at providing some examples of successful initiatives from other Indigenous communities and consisted of three case study posters: Food Sovereignty Assessment Tool from the First Nations Development Institute; ‘Imi Pono no ka ‘Aina Student Enrichment Program; and Hopi Tutskwa Permaculture Institute. The second component was an activity wherein community members (Native and non-Native) were invited to share problems they saw in the community, the kinds of solutions they had in mind, and what a successful resolution would look like. Appendix 3B contains the artifact used to gather this community input.



Figure 3.5. UCB Innovation Booth at the PPN Big Time in 2017

2017 STEAM Summer Academy Workshops

Ukiah | July 19, 20, 31 and August 1, 2017

The UCB team was also invited to facilitate some STEM activities at the PPN's annual Summer STEAM Academy. This summer program served Native American 7th- and 8th-grade students in the Ukiah Unified School District. Participating youth engaged in activities connected to STEM, sports, culture/art, and wellbeing. For a more detailed explanation of the STEAM Summer Academy, please refer to the data collection section in Chapter 2. While the summer academy lasted three weeks (July 17th - August 4th, 2017), the availability of the UCB graduate students only allowed them to design and facilitate two workshops distributed across four 1.5-hour sessions. The first workshop, called *Inventfull – Inventions for Good*, occurred on July 19th and 20th, 2017 and aimed to motivate children to think about personal challenges connected to food, energy, water, and wellbeing; to brainstorm potential solutions; and to use robotics to prototype their solutions. The second workshop occurred on July 31st and August 1st, 2017 and centered around tensegrity structures. Approximately 12-15 children participated in each workshop.



Figure 3.6. Native Youth and facilitators at the Robotics Workshop - 2017 STEAM Summer Academy

The Big Time Innovation Booth and STEAM Summer Academy workshops provided the opportunity to nurture the nascent relationship between team members from both teams and allowed the new UCB students to interact with and participate in tribal events.

The remainder of 2017 was devoted to further defining the collaboration. In the next joint face-to-face meeting, the UCB team shared the findings from the Big Time Booth, which were validated by the PPN team. Subsequently, the PPN team shared their strategic plan as well as their funded and not-yet-funded initiatives as the basis for narrowing down the possibilities for collaborative projects. Following this meeting, the UCB team continued meeting to brainstorm potential research projects and their concomitant IRB protocols. By the end of the year, Prof. Agogino saw the PPN-UCB collaboration as a good opportunity for Global Poverty Practice (GPP) minor students to do their required summer practice experience. Thus, in preparation for the activities for the following year, the PPN-UCB partnership was included in the list of GPP internship opportunities.

2018 | Makerspace Becomes the Main Co-design Project

Chronological Summary of the Co-design Process in 2018

In 2018, the co-design of a STEM makerspace became one of the gravitational centers of the PPN-UCB partnership. After devoting the first months of this year to narrowing down the potential projects, the PPN's educational director emailed the UCB team in March and tangentially mentioned that the tribe was in the process of developing a STEM lab. She requested technical and conceptual assistance from the UCB team, and, given the strong connection with graduate students' interest, the idea immediately gained traction. As the result of dialogues between the teams, the STEM lab was rethought as a culturally sensitive STEM makerspace.

Inspired by design thinking and guided by co-design approaches, significant effort was devoted to better understanding the tribe's aspirations and goals for the new educational setting. To this end, leaders of the main tribal educational initiative (i.e., the Pomo Youth College and Career Success Project [PYCCSP]) became our primary contacts. One of the main co-design activities, the Making

Makers community workshop, took place at the would-be makerspace. Its goal was to show the local Native community what a makerspace is and how it could fit their specific context and promote academic success to academic success in STEM fields. The initial goals for the makerspace, as well as general guidelines for the ‘look and feel’ of the workshop, were provided by the tribe’s educational liaison and the Career Counselor of the PYCCSP. They suggested holding an informal gathering where people could walk freely around different stations, see how the machines work, and what kinds of projects could be made. This trade-show format would also give participants the freedom to interact with each other and with the activities as they saw fit. The PPN team worked on the logistics of the event, while the UCB team was in charge of designing the stations. Though both teams agreed that a guiding idea would be weaving old and new technologies of making, conversations with two PPN staff members (one Native and one non-Native) surfaced some unanticipated complexities around this theme, and it was ultimately dropped before the June Making Makers event.

As in Summer 2017, the UCB team (which now also included undergraduate students) was again invited to be part of the PPN’s Summer STEAM Academy. A very similar robotics-based workshop to that conducted in 2017 was facilitated for tribal youth. As part of the makerspace co-design process, two members of the PPN team and I attended a FabLearn training at Stanford University. The concrete outcome of this training was the design of a maker curricular unit that fit the tribe’s unique context and goals. During the Fall, the teams visited one of the UCB makerspaces, met with its manager and discussed issues linked to equipment, installation, and security, among other things. To continue engaging families and getting feedback, the two teams decided to hold some hands-on making workshops (i.e., 3D printing, stop-motion) at the would-be makerspace. Three workshops were hosted by the PPN, and two of them were co-facilitated. During this period, intra-UCB occurrences again outnumbered inter-PPN-UCB occurrences for the spring and fall, largely due to the high frequency of intra-UCB emails and meetings (Figure 3.2, center).

The similarity of inter-PPN-UCB and intra-UCB occurrences during the summer follows from the teams’ participation in community events such as the Making Makers Community Workshop and the STEAM Summer Academy. As in 2017, the average representation of the non-Native UCB graduate students and non-Native PPN staff members (Figure 3.3, center, orange and light blue) remained higher than average UCB faculty/researcher and the PPN council representation (Figure 3.3, center, dark blue and yellow). The switch between UCB graduate students and PPN non-Native representatives was caused by two factors. First, for the spring and summer, the PPN non-Native sub-team decreased in size to one person. Second, one of the three members of the UCB graduate student sub-team was continually traveling internationally to finish his dissertation. The rise in the representation of UCB faculty/researchers resulted from one of the original team members of the PPN-UCB partnership, Dr. Yael Perez, rejoining the team in the role of senior researcher. Finally, the UCB team attended the 2018 Big Time as participant observers and once more facilitated a robotics workshop in the 2018 STEAM Summer Academy, which engaged a similar number of Native PPN youth as in the previous year (Figure 3.4, center). New in 2018, 3D printing and stop motion animation workshops run in the fall further expanded face-to-face interaction with the Native community.

Events

Making Makers Community Workshop | June 8th, 2018

Ukiah | June 8th, 2018

The event Making Makers was hosted by the PPN and co-facilitated by the PPN and UCB teams. It took place at the would-be makerspace and lasted approximately four hours. An opening prayer set the tone for the informal gathering and was followed by a welcome message given by tribal vice-chair

Angela James and by the career counselor of the PYCCSP. The idea of learning through making and the potential of makerspaces was addressed by Prof. Agogino. Each of the eight table stations (Table 3.4) was presented by its facilitator, and community members were invited to walk around to share ideas and thoughts using the posters on the walls (Figure 3.7).



Figure 3.7. Making Makers Community Workshop

Table 3.4. The eight stations at the Making Makers Community Event

Station name	Description
Shopbot	Showcase examples of projects created with a Shopbot. Present a video of the machine in action.
3D printer	Expose participants to the potential of a 3D printer by seeing it in action and interacting with pre-printed objects.
Laser cutting	Expose participants to the potential of a laser cutter by seeing it in action and interacting with a set of laser-cut projects.
GoGo boards	Showcase examples of how we can sense the world and act on it using robotics.
Maker Studies	Present three makerspace case studies to illustrate a diversity of topics, groups of people, and approaches in order to highlight their benefit to youth and the community (not only to get people excited about STEM making, but also to see if any of these makerspaces interest them).
Just Make IT!	Hands-on activity so participants can experience making. People were invited to make an LED greeting card for someone they love.
Robotic Arm	Present two concrete and more elaborate projects that have been created in makerspaces: one, a robotic hand designed and presented by one of the tutors of the Academic Success Center; and two, Eyeiris, the final project for the Critical Making course of one of the UCB graduate students.
Eyeiris	

Station name	Description
Make your makerspace	Understand how we could design/shape the space in a way that will make the Native American tribes from Mendocino County feel the space belongs to them, and that it's imbued with their identities. Tree poster-metaphor.

The event ended with a student award ceremony organized by the Academic Success and College Prep Resource Center. Please see Appendix 3C for a flyer with the full agenda. During the UCB team debrief, it was emphasized by several members that ‘attendance was low’ and that it ‘dwindled throughout the afternoon, even though the prizes were awarded at the end of the event’ [UCB Files. 2018 June 8]. In total, roughly 20 community members attended. I will later discuss the issue of low attendance, which is related to the representation of Indigenous perspectives in the makerspace project.

2018 STEAM Summer Academy

Ukiah | June 19th-21st

The UCB team was once more invited to facilitate a STEM activity at the PPN’s annual Summer STEAM Academy (July 13th-July 3rd). Both the general academy and the workshop facilitated by the UCB team mirrored the format and content of the previous year. For three days, five members of the UCB team facilitated a robotics workshop framed around issues linked to food, water, energy, and wellbeing. Participating youth were invited to think of themselves as designers and to use sensors and actuators to create prototypes. In contrast with 2017, some of the final projects were available at the 2018 Big Time, and some of the youth shared their creations with the larger community.

STEM Teaching for the 21st Century: From Learning Targets to Curricular Units. FabLearn

Palo Alto | July 23rd-27th, 2018

Aligned with the capacity development goal of training tribal members, the UCB team obtained two scholarships for the course *STEM Teaching for the 21st Century: From Learning Targets to Curricular Units*. This course was offered by the FabLearn Community, a group of scholars and researchers specializing in the implementation of makerspaces in schools. During this five-day class, two PPN staff members (a PPN citizen and one non-Native person) learned about inquiry-driven, project-based learning in makerspaces and digital fabrication settings. Over the course of that week, they worked alongside one of the UCB graduate students to develop a curriculum unit, called *Living in two worlds*, that suited their unique context. The big idea underlying the *Living in two worlds* unit was “If you do not know where you’ve come from, how do you know where to go?” Its aims were twofold: first, to teach children to acknowledge historical oppression and trauma and to help them realize how these things link to their current situations; and second, to challenge children to approach these limitations as problem solvers, artists, scientists, activists, computer scientists, and historians.



Figure 3.8. PPN team members at the Stanford training. They used the *making tree* created at the Making Makers Community as a base to design their makerspace curriculum

Visiting a Makerspace at UC Berkeley | September 21st, 2018

Berkeley | September 21st, 2018

The PPN and UCB teams decided that visiting one of the UC Berkeley makerspaces would stimulate the co-design process. Two non-Native PPN staff members, along with some members of the UCB team, toured the Invention Lab and met with its manager. The conversation revolved around the equipment in the space, its installation and training practices, and security protocols, among other things. The UCB makerspace manager also shared information around products and estimated prices. The teams then met to discuss future activities (e.g., additional planning sessions, workshops, and maker activities). During this conversation, some conceptual tensions around the makerspace emerged. The shifts linked to these tensions are detailed in Chapter 4.

Makerspace Workshops | November 2nd and 16th, 2018

Ukiah | November 2nd and 16th, 2018

To keep the momentum around the makerspace and to continue getting community feedback, the two teams decided to hold some hands-on making events with the PPN community. The UCB team designed and facilitated two workshops that were hosted by the PPN at its makerspace. The first workshop, Spirit Animals, aimed to familiarize participants with 3D design (i.e., TinkerCAD) through the design and 3D printing of spirit animal figurines, a Native concept that honors connection with nature through identification with animals (Figure 3.9). In the second workshop, participants were invited to tell stories using backgrounds of local places such as Ackerman Creek (Figure 3.9). Each session concluded with a group reflection and brainstorm about the kinds of activities they would like to have in the makerspace. Approximately 12 people, children, and adults participated in each workshop.

A third workshop, devoted to the creation of games, took place in December. However, since the UCB team was unavailable, it was fully designed, facilitated, and hosted by the PPN team. Given the PPN-internal nature of this event (an outlier), it has not been included in the corpus of data.

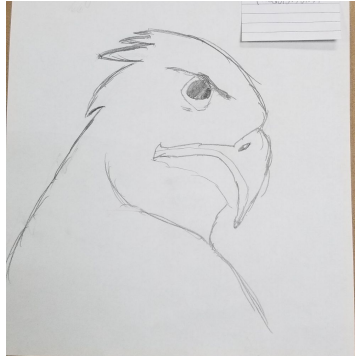


Figure 3.9a. A spirit animal drawing from one of the participants



Figure 3.9b. Participants working on the creation of a stop motion story

Though the makerspace was still under development, the activities of 2018 solidified a culturally responsive makerspace as the anchor of this generation of the PPN-UCB collaboration. The activities of 2019 would clarify the best ways to proceed with this work.

2019 | Co-Designing Locally

Chronological Summary of the Co-design Process in 2019

In the first part of 2019, the UCB graduate students presented their formal research-design plans to the PPN. The *makerspace project* plan had two overlapping phases:

- a) interviewing people from the Native community to establish a foundational understanding of their needs and hope from such a space, and
- b) holding four half-day co-design workshops with community members.

Each workshop would have a different focus:

- 1) the values the community wanted to see expressed in the educational space;
- 2) the tools, materials, and machines the community would like to have available in the space;
- 3) wellbeing and its potential intersection with STEAM fields; and
- 4) future intercommunity engagements such as field tours to museums, universities, or other makerspaces.

Despite a precedent of facilitating similar extended co-design workshops in 2007-2008, vice-chair James expressed that a four-hour workshop could be intimidating and that engaging people in such a ‘high commitment’ activity would be very challenging. This issue about commitment and time ended up being quite significant, and I give it further consideration in the discussion section toward the end of this chapter.

As the teams were finalizing the agenda for a follow-up meeting in which the ‘gameplan for the tribal learning environment’ would be better defined, a unique and unexpected opportunity to run a planning session arose. The educational director shared that Native H.O.P.E. running at Ukiah High had a time slot available the following morning between 10:00-12:00 noon. Since the trip was already coordinated, I decided to take the opportunity, despite having only a few hours to prepare. As I describe in further detail below, my participation in this training motivated me to relocate temporarily

to Ukiah.

With explicit permission from the tribal council, I moved to Ukiah for over a month during the summer. Co-location allowed me to spontaneously participate in some tribal activities (e.g., the STEM summer academy,²² the cultural camp) and to have frequent informal interaction with community members. Although participation remained a challenge, thanks to the help of the educational director, I was able to conduct 21 semi-structured interviews with Elders, adults, and youth by the end of my stay. I devoted the remainder of the year to the transcription and preliminary analysis of interviews. As in 2017 and 2018, a common pattern repeated: intra-UCB occurrences surpassed inter-PPN-UCB team communication (Figure 3.1, right). This pattern only changed in Summer 2019 when I moved to Ukiah and began interviewing community members (Figure 3.2, right).²³

In 2019, the average sub-team representation of the non-Native UCB graduate students and non-Native PPN staff members (Figure 3.3, right, orange and light blue) continued to outpace representation by the UCB faculty/researcher and the PPN council (Figure 3.3, right, dark blue and yellow). The difference in average representation between non-Native PPN staff members, the UCB faculty/researcher, and PPN council members is markedly reduced, largely due to decreased representation by the UCB faculty/researcher. However, though not captured due to their informal nature, inter-PPN-UCB team interactions and PPN.nNA participation likely increased during my time in Ukiah because the educational director was gracious enough to host me in her home. Finally, face-to-face interactions with Native PPN individuals outside the project team increased dramatically (Figure 3.4, right) due to my participation in the Native H.O.P.E. Training (Helping Our People Endure), the Cultural Wellness Camp, and the interviews. In summary, the 2019 trends show that my relocation to Ukiah helped to significantly increase community participation, which I will examine in greater detail in the discussion section toward the end of this chapter.

Events

Native H.O.P.E. training

Ukiah | April 19th, 2019

The PPN hosted a four-day training for their youth called Native H.O.P.E. (Helping Our People Endure) from April 17th to 19th. On their webpage, Native Pride, the American Indian non-profit organization that offers the training, describes Native H.O.P.E. as “a peer-counseling (youth helping youth) curriculum that focuses on suicide prevention and the related risk-factors such as substance abuse, violence, trauma, and depression” (n.d, n.d.-b). Through different activities, participants are encouraged to share openly and honestly about the “challenges in their lives and make commitments to make positive changes in their attitude and behavior.” Peer-counseling and training community members are at the core of the training’s mission. The former refers to developing Native youth capacity to help their friends get through crisis situations and make referrals for support. The latter is linked to training adults to continue providing prevention and leadership activities.

I was offered the opportunity to facilitate a 2-hour ‘planning session’ during the first half of the last day of the training. After introducing myself and explaining the project I was working on, I introduced the *wellness tree* activity (Figure 3.10). First, I invited participants (both youth and adults) to

²² As in previous years, part of the STEAM Summer Academy was facilitated by the UCB team. In 2019 this endeavor was designed and implemented by UCB undergraduate students.

²³ I have coded interviews as face-to-face meetings.

think about what wellness meant to them. The activity was framed by a tree analogy in which we could think of the roots as what gives life, holds, and grounds wellness. The trunk is wellness itself, and the branches could be activities that help us to be well. I asked them to first capture their thoughts on the tree paper print-out I gave them, and then to share their thoughts within small groups (already established in the previous days), and to create a collective wellness tree. Finally, each group was invited to present their tree to the rest of the participants.



Figure 3.10. Wellbeing tree of one of the small teams. This team went above and beyond the prompt of the activity and incorporated some words in participants' own language.

Using the first activity as framing, I next invited participants to dream about a place that would promote wellness. I asked each group to specifically think about what the place would look like, or similarly, what kinds of spaces they would like to have, and then to draw it on a big, collective poster (Figure 3.11). Once they were done, I asked them to think about what kinds of activities and things (materials, tools, etc.) they thought should be available, and then to capture them on a Post-it and place them where they thought they belonged on the big poster (blue Post-its in Figure 3.11). Finally, I encouraged them to think about the people they would like to spend time with in those various spaces, to write their names on Post-its of a different color, and to, once more, place them on the big poster (yellow Post-its in Figure 3.11).

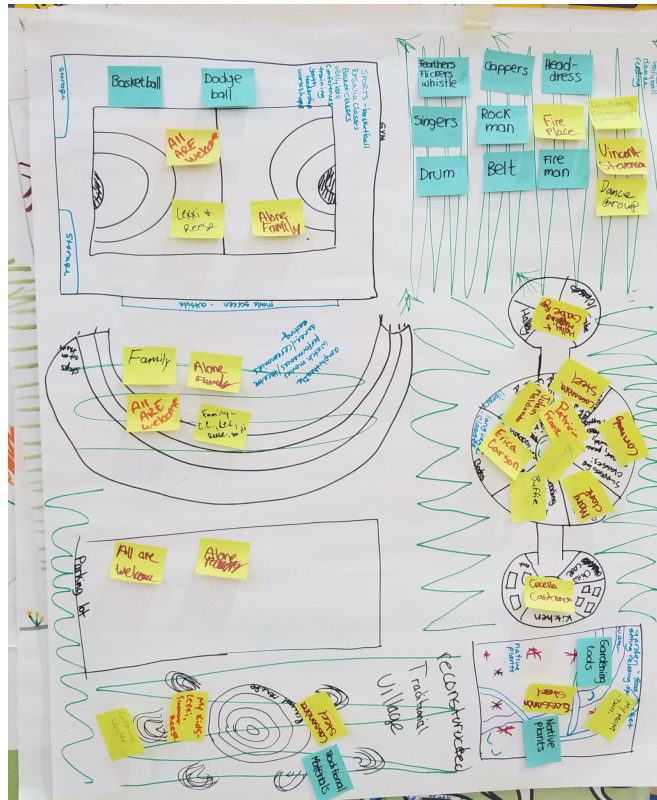


Figure 3.11. Ideal wellbeing space created by one of the small groups at the Native H.O.P.E. training

As a result of my participation in this event, and from a conversation with the educational director right after the H.O.P.E. training, it became clear that co-location would be the best way of continuing with the co-design process.

Living in Ukiah

Ukiah | April 19th, 2019

Until this point, the PPN-UCB partnership relied primarily on long-distance interaction, with specific and planned face-to-face encounters. The challenges in implementing the formal research and design plan, along with the valuable community engagement from the Native H.O.P.E. training, pointed to the necessity of changing strategies. Specifically, it became clear that joining already established tribal activities and creating additional ‘low-commitment’ activities would be the best, if not the only, way of increasing community participation. Thus, I reached out to the tribal council via email and explained to them that I realized that “being so far away makes it hard for the community to get to know me (and vice-versa)” and that “the relationships with community members are key for the successful creation of the learning environment that properly serves PPN’s need to develop a culturally appropriate []-Space for tribal youth”. I asked for their authorization to move to Ukiah for at least a month during that summer. The vice-chair replied promptly and granted me the desired permission. I moved to Ukiah on June 9th and stayed until July 14th. During this time, I co-facilitated the Cultural Camp Wellness Booth and conducted semi-structured interviews, both detailed below. I also had the opportunity to informally talk to PPN staff members, both Native and non-Native, to more easily coordinate meetings with council members, to be a participant observer throughout the STEM Summer Academy, and to informally spend time with the participant tribal youth.

Cultural Camp Wellness booth

Mendocino County | June 28th, 2018

The tribe's annual cultural camp was held from June 27th-June 30th. As described in Chapter 2, campers are given the opportunity to engage with different kinds of activities such as learning to weave baskets, taking a yoga class, or joining a workshop about historical trauma. During the second day of the camp, people were invited to participate in the wellness booth, a space that was collaboratively created by the PPN's Environmental Department and the UC Berkeley team. Guided by the sense of relaxation and openness that predominated the whole gathering, people were asked to think about a word or phrase that captured what wellbeing meant to them, to write it down on a card, and then to hang it so other people could look at the cards (for some examples of the cards see Appendix 3E).

Semi-structured Interviews

Mendocino County | June 28th-July 12th, 2018

After I relocated to Ukiah on June 8th, the educational director and I started to plan interviews to better understand community members' thoughts and experiences around education and STEAM education. The plans were shared and approved by vice chair James, and we started recruiting participants. Our recruitment criteria stipulated that potential interviewees 1) be at least 10 years old, and 2) be Native American, work for a Native American Tribe, or have a close relationship with the Native community. The recruitment flyer explained that participation would entail an interview of up to 1.5 hours, audio and video recording of the session, and a gift card in recognition of their time. I contacted PPN administrative staff via email and asked them to help us redistribute the invitation to the broader Native community. I also posted a flyer at the Pomo Academic and Success Center located in downtown Ukiah. However, the lack of responses triggered a change in recruiting strategy.

The educational director and I started talking to people face-to-face. We explained the makerspace project and why we thought talking to community members would be essential. Our verbal invitations were of a nature such that people could reject the invitation. The first interviews occurred at the cultural camp, and many people (many Elders and a few youth) declined our invitation. Some of the adults who were initially indecisive about participating shared that, by the end of the interview, the conversation had actually energized them. Therefore, when asked if I could reach out to them for a potential follow up, they happily agreed. Recruitment efforts continued until we got some representation from three age groups: Elders, adults, and youth. Ultimately, I was able to conduct 21 semi-structured interviews that engaged 24 individuals. The educational director was essential to achieve this level of participation. The aim of the interviews was to better understand the community's own conceptions of wellbeing and STE(A)M

The semi-structured interview protocol consisted of four sections. The first section was a set of ice-breaker questions designed to help the participants and the interviewer to feel comfortable with each other. The second section addressed participants' perspectives on wellbeing/wellness and potential links to their culture. The questions in the third section invited participants to share their thoughts about STEAM fields and how, if at all, they viewed STE(A)M in relation to their culture. The final section focused on participants' experiences with schooling. (To see the interview protocol please refer to Appendix 2A in Chapter 2.)

Following my return from Ukiah in July, I devoted the remainder of the year to transcribing and analyzing the interviews.

2020 | Epilogue

The beginning of 2020 followed the same trend as 2018 and 2019. New undergraduate students were introduced to the partnership through presentations of the projects from previous years. Once more, a joint face-to-face meeting was arranged to introduce the new cohort of UCB students to the PPN tribe, for the PPN to share about new and ongoing projects, and to (re-)define opportunities for collaboration. At the same time, Prof. Agogino and Dr. Perez wanted to seize the opportunity to “present [...] in more detail, the Indigenous CoInFEWS workshop that [UCB was] organizing with partners from University of Arizona, University of South Florida and with Diné College on the Navajo Nation who will be hosting the event.” The UCB team wanted to invite community partners and emphasized how honored it would be to have PPN representation. After some time, the in-person meeting was scheduled for April 3rd, 2020. The plan for the *makerspace project* was to continue with the second phase of the research-design plan, the facilitation of co-design workshops with the community. In February and March, the COVID-19 pandemic upended all plans. Subsequent events and meetings were either canceled or moved online. The April 3rd meeting was the first major event to happen on Zoom. In April 2020, I caught COVID-19 and was out sick for about a month. I continued to participate in the online events,²⁴ but as the world descended into unprecedented chaos and uncertainty, later in the year it became clear that it would be very difficult to conduct further work with the community, and the distance slowly weakened the connections I had created with the community. Local interviews, workshops, and the work of building the proposed learning environment would remain unsafe for a long time. Towards the end of 2020, as the vaccine started to be rolled out, I realized that it would be unfeasible to collect further data or start space design and construction. A decision was made then to conclude data collection, re-scope the research questions, and focus on the process of design rather than on the (now impossible) outcome of designing a space with the community.

Discussion

Based on the timeline and analysis of events and communications (occurrences) presented above, I next contextualize the makerspace project work within the goals and commitments of the guiding design and research frameworks. I also reflect on challenges that emerged within the makerspace project that complicated or obstructed progress toward those theoretical goals and commitments. I propose both qualifications to the theoretical frameworks and practical steps that can better align community-serving design work with the needs and realities of the peoples it aims to serve.

Commitments and Challenges to Community Engagement in Social Change Making Projects

Both the design and research frameworks that guided the makerspace project position community participation as essential to success. Sitting somewhere in the middle of the participatory design spectrum, co-design projects such as the makerspace project rely on stakeholder involvement, though

²⁴ As a response to the pandemic, the tribe hosted a series of virtual workshops. These events were advertised on Facebook and open to the general public in general. I participated in the Pomo Basket demonstration and the herbal medicine workshop facilitated by basket weaver Corine Pearce.

to an extent that is somewhat less clearly defined than in user-centered design on one extreme or user-led design on the other (Steen, 2012). Moreover, inspired both by social design-based experiments (Gutiérrez, 2016; Gutiérrez & Jurow, 2016; Gutiérrez et al., 2020) and by participatory design research (Bang & Vossoughi, 2016), the makerspace project's goals hinged on community participation to define and monitor progress toward jointly negotiated design goals. Situated within this genealogy of scholarly work, the makerspace project's goals of "social change making" additionally specifies its aims to expand equitable forms of learning and teaching that contribute to a socially just democracy (Bang & Vossoughi, 2016). Such work can result in effective interventions that cultivate transformative agency amongst historically marginalized communities but only when attention is paid to the ways in which normative power dynamics can be reinscribed by the research process itself, often by articulating the tensions that emerge within the project work. The openness to questions, concerns, ways of knowing, and designing that characterize social change making projects can only be achieved in close, continued collaboration with the communities such projects aim to serve. In line with this, many of the projects described in the literature are multi-year endeavors often led by experienced scholars or activists who might have previously been in contact with the community, or who have roots in the community themselves. Starting something like this from scratch, in the context of a dissertation-sized research project, is very challenging due not only to the lack of time to properly go through several cycles of multi-year work, but also due to the challenges involved in identifying stakeholders and understanding the more subtle characteristics of their interaction. In this case, for example, there was a particular delegation dynamic, and therefore most of the inter-PPN-UCB interactions occurred between non-Native UCB graduate students and non-Native PPN staff members. That is, despite the project's theoretical commitments and the project team's best intentions, Native community members' involvement was low. Perhaps this type of delegation has been historically successful for the tribe in many other projects—but it did not work as well in the makerspace project. Since a typical "STEM" or "maker" project is often associated with equipment, curricula, and space, perhaps there was a perception that it was more about 'building the space,' while in fact a more crucial step was establishing relationships to worldviews and values of the Native community – which could not be achieved by delegation.

In addition, the above commitments to community participation take on an extra weight in design and research work with Indigenous communities. The voices and worldviews of these communities have historically been silenced and, thus, may require more careful time and attention to recognize, understand, and incorporate into project work. Indigenous scholars advocate for design and research practices that disrupt historically shaped inequities; cultivate transformative agency within communities (Bang & Vossoughi, 2016, p. 29); shift power and authority away from researchers to position community members as experts in social and historical complexities; and strengthen partnerships with non-dominant communities through critical pedagogy, historicity, and dialogue (Bang & Vossoughi, 2016; Gutiérrez & Vossoughi, 2010).

Synthesizing these design approaches (Steen, 2012) and collaborative design research practices (Bang et al., 2016; Bang & Vossoughi, 2016; Gutiérrez et al., 2020), a novice designer could conclude that a social change making project should involve both community-led design and community-led research (Figure 3.12, indicated by the star).

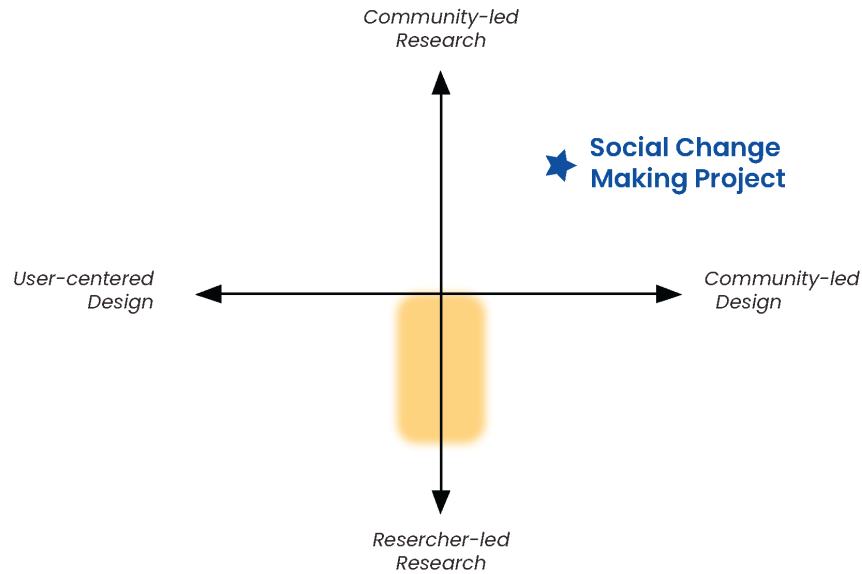


Figure 3.12. The blue star represents my interpretation of what a Social Change Making Project entailed. The orange rectangle represents the space the project occupied in reality.

The case study of the makerspace project shows that achieving substantial and stable tribal involvement can be extremely challenging. In the three years of the PPN-UCB makerspace partnership, intra UCB interactions typically exceeded inter-PPN-UCB interactions, with one notable exception when I physically relocated to Ukiah. However, Figure 3.4 demonstrates that there were events with significant community participation. To make sense of these two seemingly contradictory facts, I think it is useful to distinguish between two types of community participation: on one hand, *representative regular participation*, where tribal members are an integral part of the design/research team and therefore engage in everyday kinds of meetings; and, on the other hand, *general community participation*, where the core team interacts with the broader community (e.g., Big Time, Native H.O.P.E., etc.). The first type is essential for all stakeholders partaking in the ‘nitty-gritty’ of design activities throughout the collaboration, while the second category is important for getting broader community input and ideation of project goals and success metrics.

As a result, the makerspace project’s research was less community-led than my interpretation of the guiding frameworks (Figure 3.12, orange rectangle). Additional contingencies of real-world design and research work contextualize this finding: the PPN is a relatively small tribe; the PPN staff members wear many hats and have many responsibilities; and the UCB students were academically motivated to devote their time and energies to this project. Indeed, if some of the aim of social change making projects is the promotion of transformative agency and the disruption of normative power dynamics between designers/researchers and “the users/researched,” can these goals be achieved with such minimal interaction with the historically marginalized individuals and communities? At the same time, is it legitimate to request more participation from the community given that they, too, have their own (even greater) time limitations? These questions might not have answers, but they are essential anchors for reflection. Furthermore, this type of project follows an interactive and fractal-like trajectory. Each level of design unfolds into a series of smaller design decisions and tasks, and so on (see Figure 3.13). This creates uncertainty about when joint participation is essential and at what level, without imposing additional burden, while also making sure that the community is involved in different levels of decision making. I next propose some recommendations that could increase participation and ameliorate this concern in other community-serving work.

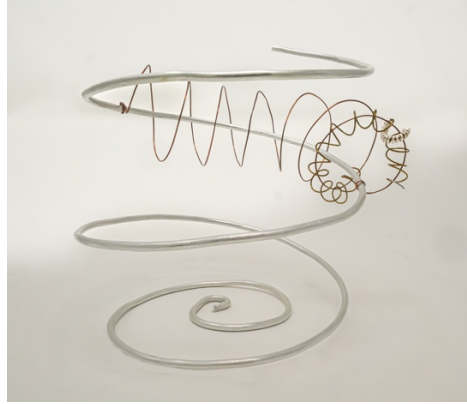


Figure 3.13. Model that shows the iterative and fractal nature of a design process. Level 1, the main silver spiral, represents the design of the PPN's makerspace, which in turn required the design of many community events/activities, in this particular example the design of the Making Makers Community Workshop (Design Level 2, secondary copper spiral). In a similar fashion, the Making Makers community workshop necessitated the design of eight stations, among them the 3D printing demo station (Design Level 3, tertiary golden spiral). At the same time each station needed an artifact to get feedback from the community (Design Level 4, quaternary silver spiral - Feedback poster).

Practical Implications for Community-Engaged Design and Research

Departing from my interpretation of what a Social Change Making Project was, the degree of community engagement in the makerspace project fell short of my goals. Back in late 2018, one attractive yet problematic explanation I had for this shortcoming was that the community members simply did not care enough about the makerspace project or its potential to promote community wellbeing. My deficit perspective could seem apt, since our extended efforts in organizing formal co-design workshops were met with delays and a lukewarm reception at best. However, the outpouring of volunteerism and engagement evident in pre-existing community events such as Native H.O.P.E. and the Cultural Camp flatly refuted my initial explanation and proved the community's deep commitment to fostering wellbeing, especially for their youth. Thus, in fact, it was through participating in such pre-existing events that the most face-to-face contact with Native community members was achieved. Thus, this case study suggests that leveraging such pre-existing events (subject to community approval) could be one way to increase spontaneous community participation without placing undue burden on community members' time by introducing numerous new events. Potential mismatches in expectations of regular participation could be ameliorated during planning meetings by explicitly designating members of the core team in ways that Indigenous representation is stable, defining a regular meeting schedule, and specifying mechanisms to continuously monitor participation. Another significant limitation on community engagement was the project's funding model. Even though apparently less of an academic topic, the experience shows that small details about how funding is configured can bring significant difficulties. These configurations are typical in many US-based universities, and likely common to many similar projects. In this particular case, the project was initially funded by a US-based traineeship grant, which carried many limitations. First, we were unable to hire PPN community members for the project, which could have helped to achieve Native American representation on the research and design team. This is a common limitation of many grants: even when it is possible, the hiring of non-research staff is often complex, time consuming, and bureaucratic. Additionally, my status as an international student posed limitations on how I could be compensated for the work and travel, and any other research-related expenses required applying to additional small grants. These issues point to the fact that universities might not be well-equipped to fund projects that require intense community participation.

On the PPN side, the tribe's economic model imposes additional financial challenges. Unlike other tribes that own casinos—one means of achieving economic sovereignty—the PPN must constantly apply for grants from the local, state, and federal governments. Furthermore, the tribe's financial situation has been exacerbated as the result of the highly problematic historical and legal relationship between the federal state and Native Nations, which has unjustly forced the PPN to buy their ancestral land twice. Thus, without funding for this project, the PPN staff members effectively had to borrow time against their other, grant-funded work. As a result, the makerspace project was given understandably lower priority and time allocation.

Taken together, these issues of funding and resources were more than merely bureaucratic obstacles. In fact, the data shows that the realization of the full vision of agentic participation requires more than theoretical disposition and goodwill on both sides: it requires resources that often go above and beyond what is typically available to graduate students. I believe that successful funding models should provide funds for a comprehensive planning phase and subsequent design phase. The budget should consider funding for all team members—independently of their institutional affiliations and citizenship—and costs associated with bringing the teams together for extended periods. Today, as more and more students become interested in this type of work, adequate resources and flexible funding models will be increasingly crucial for the success of similar projects.

Finally, it is worth emphasizing that internal PPN activity relevant to the design project (i.e., within communications, events, and reflections) is not part of the corpus of data. For example, there are no data about the third maker workshop in December 2018, which was fully designed and facilitated by the PPN team. Likely there were other valuable PPN meetings and conversations that took place outside my sphere of view and thus are not included in the data. This data is key to arriving at a holistic understanding of the co-design project. The absence of these 'unseen' occurrences points to a clear limitation of this work that should be addressed in future research. Nevertheless, it is also a contribution of this work: It suggests that researchers should carefully design their studies to privilege these kinds of data, which might present numerous challenges in terms of privacy, consent, and integrity.

Conclusion

In this chapter, I started by explaining that while the flexibility of the definition of co-design as a design approach allows for co-design processes to be suitable to various realities and contexts, it also might jeopardize accountability and the creation of a coherent body of knowledge. While the field of Indigenous making and sharing is growing (Barajas-López & Bang, 2018a; Searle et al., 2018; Tzou et al., 2019), there is a lack of research literature that delves into the co-design processes themselves. Consequently, by providing a detailed account of the co-design process of the PPN makerspace project, combining qualitative descriptions with a novel data logging and analysis method, I expect to contribute to a body of literature that informs a more robust theorization of co-design as an approach that can guide collaborative projects with non-dominant communities.

I addressed the question 'How was the co-design of a culturally sensitive makerspace instantiated in practice?' I answered the question qualitatively by providing annual summaries of the co-design process, emphasizing events with community participation. Quantitatively, I presented a comparison between the amount of the exchanges within the UCB team (Intra-UCB) and between the teams (Inter-PPN-UCB), and also an analysis of the proportions of team representation—bound solely to Inter-PPN-UCB occurrences.

Findings show that in the three years of collaboration when I was part of the UCB team, intra-UCB occurrences were generally higher than the ones between the PPN and its community, and the

UCB team, with two exceptions. The first one happened in summer 2018 when the number of inter-PPN-UCB occurrences equaled the number of intra-UCB occurrences. The second one took place in summer 2019 where, for the first time, the number of inter-PPN-UCB occurrences was substantially higher than intra-UCB occurrences. This spike was the result of my relocation to the Ukiah area, which permitted meeting with the PPN more frequently and interviewing community members. When analyzing only inter-PPN-UCB occurrences to better understand sub-team representation, findings reveal that on average the representation rates for UCB non-Native graduate students and PPN non-Native staff members were consistently higher than the ones from tribal council people and PPN Native staff members. That is, despite the theoretical commitments and design sensibilities, the project usually fell short of *general community participation*, and lacked *PPN representative regular participation*—a stable Native representation in the core team. This case study suggests that leveraging pre-existing events (subject to community approval) could be a way to increase broader community participation without placing undue burden on community members' time by introducing numerous new events. Expectations for representative regular participation should be explicitly discussed during the conceptualization process and planning phase and should address issues such as the designation of members of the core team such that Indigenous representation is stable, the definition of a regular meeting schedule, and the specification of mechanisms to continuously monitor participation.

In sum, the three-year representation trends elicit questions about the representation of Native American peoples' perspectives in the makerspace project as linked to its aims of fostering transformative agency and disrupting power dynamics. While it seems evident to assume that patterns of representation of non-dominant communities have implications regarding the inclusion or exclusion of non-dominant worldviews, we should wonder whether community participation in a co-design process led by external and novice designers is sufficient to guarantee the representation of non-dominant worldviews. I will turn to this question in the next chapter.

Chapter 4

Introduction

Given that designers' worldviews influence the design process and its outputs, in this chapter I explore and reflect on the shifts I experienced as a novice non-Native designer that were particularly relevant to the co-design process of the makerspace project. My aim in this self-reflective process is to inform other researchers, especially novice, non-Native researchers, in Indigenous-serving or STE(A)M-adjacent co-design work. I start by sharing the research questions that motivate this chapter and by introducing chronological sequencing (Miles et al., 2020; Yin, 2018) as the primary analytical tool. I then apply chronological sequencing to the high resolution timeline presented in Chapter 2 and the higher-level timeline presented in Chapter 3 to identify *critical incidents* (Miles et al., 2020) characterized by discrepancy. I use these critical incidents to explore shifts that were guided by cognitive dissonances I experienced in relation to the makerspace project. I discuss the shifts in my perspectives departing from the assumption that was challenged. Concretely, the first shift surrounded my tacit assumption that access to good quality STEM education would promote wellbeing. The second shift arose from the apparent disconnect between the design of a makerspace and notions of Indigenous sovereignty and self-determination. I then bring to the table the academic courses that provided context for each shift. Concretely, I address the instructional conversations that acted as mediational tools. Finally, I conclude by suggesting that, while community participation is essential in co-design projects, it might not be sufficient to guarantee the representation of non-dominant worldviews.

Research Questions

The research questions guiding this chapter are: *What shifts, if any, were triggered when the researcher encountered Indigenous worldviews during the co-design process?* (RQ2a) and *What factors mediated the identified shifts?* (RQ2b).

Data Analysis

Chronological sequencing is a frequently used technique in single-case studies, and it is considered a special form of time-series analysis (Miles et al., 2020; Yin, 2018). This analytic strategy preserves the historical chronological flow of data and permits “a good look at what led to what, and when” (Miles & Huberman, 1994a, p. 110). Given the highly distributed nature of this co-design project, both chronologically over three years and geographically between Berkeley and Ukiah, CA, chronological sequencing is a promising method for identifying pivotal moments in the project's development.

Using chronological sequencing, I identified events where I felt some kind of dissonance. Then, using these conjectured events as anchors, I analyzed the MaxQDA dataset²⁵ for the existence

²⁵ As explained in Chapter 2, the MaxQDA dataset gathers in one place as much of the corpus of data as possible (e.g., email threads, tribal documents, field notes, reflections, memos, meeting agendas, artifacts created in co-design workshops, diagrams, etc.). In a way it is a “play by play” reconstruction of the co-design process, and it contains 947 records.

of such ‘cognitive noise.’ In some cases, the dissonance was explicitly captured in the data source (e.g., field notes – “Discussion about STEM as a western construct”), while in others, changes in disposition or discourse acted as a proxy for shifts (e.g., noting the appearance of sovereignty and self-determination in project descriptions where those themes had previously been absent). If the dissonance was confirmed, the respective event was labeled as a *critical incident* (Miles et al., 2020).²⁶

For each critical incident, I re-analyzed the pertinent sections of the MaxQDA dataset to determine whether it was linked to the potential filtering of worldviews and practices of the community. This decision was based on a comparison of the conceptualization of the project before the critical incident and after it. Through this analysis, I identified a few shifts that had catalytic effects on my reconceptualization of the makerspace project, and then selected two especially impactful changes for inclusion in this chapter. To determine the factors that mediated each shift, I analyzed the MaxQDA dataset yet again to identify relevant points throughout the process and then produced an analytical memo. The two shifts and their mediating factors are elaborated on in the Findings, below.

Limitations

This dissertation aims to contribute to the discussion of how the practices and worldviews of historically non-dominant communities might get filtered through normative epistemologies and ontologies (Bang & Vossoughi, 2016). Detecting such filters requires the creation of a continuous log of self-reflexive memos, class and field notes, documentation of meetings, multiple drafts of project formulations, and the iterative analysis of the research agenda itself—a practice I have engaged with since the beginning of my PhD program. Therefore, I made the decision to center the analysis on my own shifts as a novice non-Indigenous designer and researcher. However, looking at these changes only from my perspective is a limitation that could, and should, be addressed in future work.

Findings

Assumption: STEM Education Promotes Wellbeing

The second cycle of collaboration between the PPN and a new cohort of UC Berkeley students started in early 2017. My co-advisor, Prof. Agogino, invited me to be part of the project due to my motivation to work with Indigenous populations and my interest in design for social justice (please refer to Chapter 2 for a more in-depth discussion of my identity and positionality). In 2018, during a visit by some PPN representatives to a UCB makerspace, a shift in my conceptualization of the makerspace project became explicit. At the beginning of the collaboration, I had tacitly assumed that providing access to STEM education would improve the lives of tribal youth by increasing their understanding of the world and thereby empowering them and their communities. As the collaboration progressed, I engaged with historical and decolonial lenses that facilitated a more nuanced understanding of the relationship (or lack thereof) between Indigenous wellbeing and STEM education. The UCB makerspace visit was a critical incident highlighting a tension around whether STEM education could be an instrument for promoting Indigenous wellbeing.

²⁶ Miles and Huberman (1994a) describe critical incidents as “events seen as critical, influential, or decisive in the course of some process” (p. 115).

Critical Incident: Visiting a Makerspace at UC Berkeley / September 21, 2018

As mentioned in Chapter 3, PPN representatives were invited to visit one of the UC Berkeley makerspaces in Fall 2018. During this visit, two non-Native PPN staff members and part of the UC Berkeley team toured the Invention Lab and met with the lab's manager. Topics like equipment, budget, safety, general management, and grants were discussed [FN, R1, Sep.21.2018]. After the tour, two members from the UC Berkeley team met with the two non-Native PPN staff members to discuss next steps for the collaboration. In this meeting, I shared my main concerns regarding the project, namely the possible friction between Indigenous wellbeing and STEM fields. Concretely, I was worried about a potential uncritical adoption of already established makerspace equipment and practices, which are often heavily influenced by Western perspectives. Distinctly, I was wary that by using a 'cookie cutter model'—superficially modifying the blueprints of existing makerspaces to add a cultural dimension—the team might unwittingly reproduce a neocolonial agenda [FN, R1, Sep.21.2018]. The rest of the team responded in ways that indicated they heard this concern, but no immediate plan for resolution was created.

Mediating Tools: Decolonial Thinking and Historicity

The chronological sequencing suggests that the labeling of STEM as a product of Western perspectives, a kind of narrative until then absent from my discourse, was likely mediated by the instructional conversations that made up two courses I audited: *Language, Race, and Power* (Spring 2018), taught by Dr. Derrika Hunt²⁷; and *Survey of World History* (Fall 2018) taught by Dr. David Beecher. The former course exposed me, for the first time, to decolonial thinking, the dynamics of power structures, and systemic inequalities. Auditing the latter course allowed me to see science and engineering as multifaceted fields of human activity. Specifically, an analysis of the ideologies and values embedded in the industrial revolution made visible their current pervasiveness in STEM fields, particularly in engineering. In the following sections, I address the main instructional conversations from these courses and the ways they challenged my assumptions about STEM and its relationship to Indigenous wellbeing.

Decolonial Thinking: Language, Race and Power

At the end of Fall 2017, I serendipitously met Dr. Hunt, a person who, through her kindness, expertise, and passion, inspired me to better understand social injustices by exploring their systemic nature. Despite having already finished my MS in Mechanical Engineering—emphasis on design—and fulfilling the course requirements for my PhD program, I decided to join the *Language, Race, and Power* course she was teaching in Spring 2018. Both my friendship with Dr. Hunt and the course conversations helped me recognize and challenge many of my deep-seated assumptions underlying my worldview in general and my perspectives about non-dominant communities in particular.

At the beginning of 2018, despite caring deeply about social inequalities, I was unaware that the lenses through which I saw the world heavily influenced my understanding of social problems and, therefore, limited my perspectives about theories of change. Slowly, I started to recognize that I was born in a world full of ideologies, raised and educated in a society that heavily privileges Western thinking, and part of many systemic inequalities. In other words, the manner in which I had been socialized to the world and experienced it made me take for granted that, although there might be

²⁷ While Dr. Derrika Hunt was a PhD candidate at the time of this course, I will refer to her as Dr. Hunt from now on.

other perspectives, the way I understood the world was the ‘correct’ one. In many ways, the conversations in this course helped me to recognize the ‘Western bubble’ I had, so far, lived in.

A particularly insightful moment in the course arose from differentiating two words that often are used interchangeably: education and schooling [CN, ED, R1, p.9]. Up to that moment, I had assumed that education had been, and would always be, beneficial for all humans. In the class, however, I learned that education, or more precisely its presumed counterpart, schooling, is not universally good or neutral. This discussion was facilitated by a historical analysis of Indigenous scholars Sandy Grande (2015) and Tsianina Lomawaima (1995) that delved into how policies around ‘Indian education’ and its material instantiation (i.e., schooling for Indians) had catastrophic consequences for Indigenous peoples [CN, ED, R1, p.2].

The following short summary of the historical relationship between schooling and Native American peoples aims to emphasize that, for over 400 years of history, schooling was subservient to a colonial and white supremacist agenda (Lomawaima, 1995).²⁸ From the sixteenth to the nineteenth century, the church, supported economically and politically by the US state, worked to assimilate the ‘savages’ under the justification of saving their souls (Grande, 2015)—more often than not in a forceful way. Missionary groups developed and administered schools for Native Americans throughout the United States (Grande, 2015).

From the 19th to the mid-20th century, Indian schools were controlled and managed by the U.S. federal government. Its initial solution to the ‘Indian problem’ was to remove children from their home communities and take them to geographically and ideologically foreign places: boarding schools. During this time, the purpose of Indian education/schools was to serve the federal machine by, for example, teaching children allegiance to the U.S. government, exterminating their native languages, and abolishing their cultures (Grande, 2015). Physical and psychological abuse of Indigenous children was common. Particularly relevant to the ‘removal of symbols of savagism’ were renaming practices. New names were assigned to the children to make their pronunciation and memorization easier (Lomawaima, 1995). Sometimes, names were merely translated to English—which at times resulted in names that were perceived to be ridiculous and occasionally humiliating; other times, a combination of white names and translated Indian names were used; and in other cases, brand new names were assigned (Lomawaima, 1995). These practices represented a direct attack on Indian identity, as tribal naming was typically a central aspect of identity.

In 1906, after the boarding school system proved to be ineffective in achieving complete assimilation and became a political and economic liability, Francis Leupp, the commissioner of Indian affairs, proposed the inclusion of Indian students in public—predominantly white—schools. This strategy was widely praised for its promise to promote the ‘Americanization’ of Native children (i.e., helping them to ‘think white’) and to relieve the government’s economic burden (Grande, 2015). Analyzing these two eras of siloed and mainstreamed schooling, along with the cases of schooling practices for Latinx and Afro-American children, helped me to acknowledge the impact of colonial powers and agendas on non-dominant communities.

Comprehending Native American peoples’ histories with schooling pointed to the larger question: *Who teaches what and why?* Moreover, differentiating education from schooling can critically call power structures into question. Dr. Hunt invited us to think, from a postcolonial angle, about whether “schooling, as an institution, is redeemable” and whether “schools can be sites of education” [CN, ED, R1, p.9]. These questions emphasize the importance of re-analyzing what education means, of considering the affordances and constraints of different paths to becoming educated, and of

²⁸ For an extensive historical account of the relationship between schooling and Native American peoples, please refer to the books *Red Pedagogy* (Grande, 2015) and *Education for extinction* (Adams, 1995).

thinking more generally about *what it means to educate diverse human beings*.

After this course, questions about *why STEM education is relevant* and particularly about *why it is relevant from the tribe's perspective* started appearing consistently in the project team's discourse [MN, R1, May.10.2018; MP, May.29.2018; MP, Jun.02.2018]. By contrast, up until this point in my own learning, there was no evidence that I had identified STEM as heavily influenced by Western perspectives. The data analysis suggests that the mediating tool responsible for this new historical and epistemological understanding was the instructional conversations from the course *Survey of World History* (Fall 2018). I now turn to a discussion of this course.

Historicity: Survey of World History

As a formally trained engineer, challenging the universally positive nature of STEM fields was far from straightforward for me. My views on STEM education—having created and led K-12 STEM education programs in Ecuador, and having joined a PhD program in STEM education—hinged on its imperative function in understanding the world, improving human lives, and empowering children and their communities. Exploring the historical development of science and engineering pushed me to challenge these assumptions. The result was my arrival at a more nuanced understanding of the complex and sometimes fraught relationship between Indigenous wellbeing and STEM education.

The *Survey of World History* course focused on changes and continuities in world history from the origins of human civilization to the present. Specifically, it emphasized changes within human communities and their internal division of labor and also the story of the interaction of those communities with each other. I decided to audit this course for reasons that were not initially connected to the project. However, it unexpectedly introduced me to a perspective on science and engineering as multifaceted fields of human activity. Instead of seeing science as the main way to know reality and engineering as a way to improve reality, historian David Beecher's analyses showed how these fields had complex and often contradictory relationships with human wellbeing. Many of the taken-for-granted ideas associated with STEM fields were socially-constructed. Both scientists and engineers belong to communities of practice that inherit values, ideas, and worldviews from their larger societies, and, as such, they serve larger economic and political interests, wittingly or not [CN, IAS45, R1, p.36].

In particular, discussing the industrial revolution from a historical perspective was helpful in identifying ideologies that remain embedded in STEM fields to this day. Dr. Beecher initially suggested that the industrial revolution is usually thought of in two ways: as a story of curiosity, invention and entrepreneurship on one hand and as a story about energy on the other. While expanding on the former story, he talked about the invention of labor-saving devices and artifacts that increase efficiency. He used artifacts such as the flying shuttle, steam engines, and powered looms as examples of “inventions created by entrepreneurial tinkerers to increase productivity.” When talking about the second story, he emphasized that the industrial revolution was actually about an explosion of energy. The discovery of new resources that could power the world replaced human power with mineral power. Both narratives would allegedly “make the world function in a better, faster, and more humane way” [CN, IAS45, R1, p.36].

Dr. Beecher then invited us to consider whether such narratives are true. He asked us to compare the discourse and values around energy, technology, and progress from the 18th-19th centuries with the ones in current times. Common themes included ‘making more things, and making them faster’ as well as the continuous search for new resources and energy sources.

In the name of creating greater efficiency you, nonetheless, have to drive people even further down into oppression than they were before... A world where there is even more suffering than there was before, all in the name of a long-term improvement through technology.’ [CN, IAS45, R1, p.37]. He compared the precarious conditions of coal miners in the 19th century to modern cases of Uber

and Lyft drivers who can drive their own cars but do not have access to health care. With these two examples, he argued that introducing new innovations with the aim of making life better is a pattern that repeats itself throughout history to this very day [CN, IAS45, R1, p. 37].

The very notions of modernity and progress were created in the 18th century, both enabling that era's characteristic rate of change and inserting technology into individual and collective identities in ways that persist today. The idea that progress and modernity are valuable in and of themselves—that the new is better than the old simply because it is new—resulted in a rejection of knowledge and practices from pre-industrial times. Critically, modernity, progress, and their concomitant technological development facilitated a new way to distinguish between self and Other. Technological sophistication became a metric with which to differentiate the 'civilized' from the 'uncivilized.' Thus, studying and understanding other cultures and civilizations, especially those with different historical relationships to technologies and making, can be especially challenging; not only are the material "things" different, but the surrounding practices, purposes, and values can also be profoundly different in tacit, unrecognized ways. Through Dr. Beecher's discourse, I came to notice the ways our world—and especially technocentric spaces such as makerspaces—continues to be shaped by the effects of the industrial revolution.

Evidenced at the PPN-UCB team visit to a UC Berkeley Makerspace, I was concerned about how the makerspace project, as an instrument of STE(A)M education, might perpetuate, albeit often unintentionally, historical patterns of oppression against Indigenous people. Participation in Dr. Hunt's course on language, race, and power validated my concern in light of historically oppressive schooling systems imposed on Native communities. It also distinguished schooling from education and gave me language to continue discussing this concern with the makerspace project team. Additionally, through Dr. Beecher's *Survey of World History* course, I deepened my understanding of the dynamics between industrialization and conceptions of modernity, progress, and technology, conceptualizations that often tacitly pervade industrialized societies generally and STEM domains especially. Though the dissonance remains (and is more directly addressed by the next shift), these perspectives equipped me to better identify my own positionality as a researcher and designer and to more thoughtfully and responsively contribute to culturally informed design.

Assumption: A Wellbeing-Centered Makerspace Has Nothing to do with Indigenous Sovereignty and Self-Determination.

Having above explored factors that mediated existing tensions between the epistemological orientations undergirding STEM education and Indigenous wellbeing, I next explore factors that might mediate changes in the conceptualization of a wellbeing-centered makerspace as (un)linked to Indigenous sovereignty and self-determination. These notions are typically presumed to be limited to the legal realm²⁹ in navigating and negotiating the unusual relationships between tribal governments and the federal government (Deloria, 1998). However, my participation in the makerspace project clarified both that their interpretation and applicability transcend the legal sphere. While there is no general agreement on their definition (Clinebell & Thomson, 1977), both sovereignty and self-determination are tightly interwoven with educational endeavors. As Brayboy (2015) summarizes, "the education of Indigenous peoples is intricately intertwined with the legal/political relationship between

²⁹ Legally, sovereignty and self-determination represent two different principles. Sovereignty is a "substantive legal status that defines one of the many types of states found in the international community", and "self-determination is more in the nature of a procedural mechanism which allows those groups of people who meet certain qualifications to choose among the various international legal statuses, of which sovereignty is one" (Clinebell & Thomson, 1977, p. 713).

Indigenous peoples and the U.S. government, as well as myriad racist policies and practices that have devastated Indian children and communities” (p. 1). That is, the tension explicated above between education/schooling generally and Indigenous wellbeing is especially acute when considering the ways such schooling suppressed Indigenous sovereignty and self-determination.

Critical Incident: Preparation for Qualifying Examination / November 16th, 2018

This *critical incident* occurred while preparing for my qualifying examination (QE) and developing my dissertation prospectus. Three areas of interest framed and bounded my preparation: Native American wellbeing, Education, and STE(A)M [PP, R1, Dec.07.2018], and I presented my project as being located at the intersection of them.

While helping me to study for the exam, Dr. Hunt emphasized that the kind of transformative work I was interested in (i.e., intersection of STE(A)M education and Native American wellbeing) could not be achieved without addressing tribal sovereignty and self-determination [MN, R1, Nov.15.2018]. Until that point, I had not considered these notions because I could not see how they would play a part in a project around STE(A)M education. STEM disciplines seemed like a universally valuable set of skills for people in any context. While I started to recognize the importance of sovereignty and self-determination for tribal wellbeing, I assumed that my ‘small’ project would not have the kind of ‘big’ impact I associated with issues around sovereignty and self-determination (e.g., changes in federal legislation).

The data analysis revealed that Dr. Hunt was not the first person to bring these issues to my attention. In fact, ‘sovereignty’ was brought up in our early interactions with the tribe in 2017 [FN, R1, R2, & R3, Oct.20.2017]. Chronologically speaking, food sovereignty was identified as a metric of community success during the 2017 Big Time Innovation Booth [EM R2, Oct.21.2017]. Economic sovereignty was mentioned in our second in-person meeting as a proxy to tribal sovereignty and was pinpointed by the Tribal Chairperson as one of the areas for which the tribe needed support in general [FN, R1, R2, & R3, Oct.20.2017]. The absence of discussion around sovereignty and self-determination in subsequent activities and meetings (until mid-2019) suggests that I ‘filtered the notion out’ possibly due to its apparent disconnection with my areas of interest and due to a mismatch in our worldviews.

Mediating Tools: Sovereignty and Self-Determination

The conversation with Dr. Hunt had long lasting effects and made me wonder whether I was missing a fundamental piece of the wellbeing puzzle. So, I decided to familiarize myself with areas that were initially not on my ‘radar.’ While considering paths for moving forward with the makerspace project and my own research, I came across the Native American Studies Program at UC Berkeley and identified two relevant courses within it: *Introduction to Native American Studies II: Cultural Practice, Art, and Identity* (Spring 2019) and *Native Americans in North America 1900-present* (Spring 2020). Both courses were taught by Dr. Enrique Lima, and had a significant impact on the conceptualization of the makerspace project. While the former course explored the question of what it means to be Native American today in the context of colonialism, the latter offered a survey and analysis of issues affecting Native Americans in the 20th and 21st centuries. Both courses brought together cultural, political, economic, and societal developments connected to tribal sovereignty, Indigenous worldviews, and identities.

Sovereignty and Self-Determination: Cultural Practice, Art, and Identity and Native Americans in North America 1900-present

The critical historical account provided by these classes familiarized me with some previously unfamiliar interpretations of sovereignty and self-determination and their respective implications. In general terms, sovereignty is the inherent right of Native American peoples to self-rule (Deloria, 1969) given that Indigenous tribes were already political bodies long before the European invasion. In fact, the establishment of the United States of America as a nation-state was only facilitated by the signing of almost 400 treaty agreements between the first inhabitants and the European immigrants (Brayboy et al., 2015). These treaties were ratified by the U.S. Congress and, therefore, represent official federal recognition of Native American sovereignty and imply Native Americans' intrinsic right to determine their own futures (Iverson & Davies, 2014). Furthermore, treaty agreements remain in effect making the U.S. accountable for providing for the general welfare of the Native American peoples as well as "supplying critical social services, such as care and education" (Deloria & Lytle, 1983). In a general sense, sovereignty entails the intrinsic right of Native American peoples to determine their own futures with federal support and without federal intervention (Deloria, 1969), in the US context.

While the course *Language, Race, and Power* and preparations for my qualifying examination clarified the appalling relationship between formal schooling and Indigenous peoples (Adams, 1995; Lomawaima, 1995), the discussions in Dr. Lima's classes helped me to finally establish a clear connection between tribal sovereignty, or the lack thereof, and educational agendas. Furthermore, I was able to better grasp the interwovenness of cultural, political, economic, and societal issues connected to tribal sovereignty, self-determination, Indigenous worldviews, and identities.

On a more practical level, the critical historicity of the classes allowed me to understand that well-intentioned initiatives that do not enact *self-determination* and *sovereignty* can have devastating consequences, as in the case of the General Allotment Act. In 1887, Senator Henry Dawes authored this Act (also known as the "Indian Emancipation Act" or simply "Dawes Act") [CN, NA72, R1, p.2], which aimed to save Native American peoples by changing their way of life to more closely match Western individualistic settlement practices. The Dawes Act entailed the dissolution of previous land settlements (i.e., reservations) separating Native Americans from their land and re-settling them on smaller land parcels where they should practice individual farming. Critically, the Act did not reflect Native Americans' desires for how to live their lives (a tenet of sovereignty and self-determination), nor did it account for the central role of collective living in maintaining tribal sovereignty and self-determination. Though Dawes intended to save Native Americans from total extermination, the General Allotment Act tragically accomplished exactly what its author aimed to avoid. Its enactment resulted in the dismantling of tribal governments, the divestment of tribal territories (i.e., white settlers were allowed to buy "left over lands" from breaking up the reservations (Lomawaima, 1995)), and the collapse of Native American people's collective ways of life that were so central to tribal and individual identity.

Despite having read about these issues while preparing for my QE (Fall 2018), Dr. Lima's classes (Spring 2019 and Spring 2020) helped me understand that senator Dawes in fact represented a liberal white minority that did not subscribe to scientific racism (i.e., the notion that other races were created inferior) [CN, NA72, R1, p. 4]. Instead, he maintained that Indian culture could be 'elevated' and assimilated into the mainstream Western culture, which he saw as the key for their survival (Hurtado & Iverson, 1996). Dawes's example has anchored reflection on my work because it demonstrates how well-intentioned initiatives can backfire if they don't overtly account for Indigenous notions of self-determination and sovereignty.

In preparing for my qualifying exam, I became aware of a significant oversight in my conceptualization of the makerspace project; as with any Indigenous-serving project, I needed to

consider its relationship to the PPN's sovereignty and self-determination. My nascent understanding of these concepts developed through conversation and course participation, and I came to see them not only as legal considerations but rather as multifaceted notions that are interwoven with daily practices. I also learned an important cautionary tale of well-intentioned improvement efforts that brought deleterious results because they neglected Indigenous self-determination and sovereignty. I came to understand that, as a project that revolved around Indigenous wellbeing, the makerspace cannot achieve its goal without supporting sovereignty and self-determination, two critical components of Indigenous wellbeing. In the next section, I reflect on my learning from this and the previous shift and contextualize them for Indigenous-serving co-design projects more generally.

Discussion

On the Role of Community Participation in Co-design Projects

In this chapter, I explored two shifts that emerged in my work. First, after engaging with decolonial literature and learning about the historical roots of Western ideologies and values that permeate STEM fields, I started to wonder whether STEM education could be an instrument for promoting Indigenous wellbeing. Second, and linked to the first shift, newfound understandings of the notions of sovereignty and self-determination challenged the role of the makerspace project in promoting these notions and, consequently, Indigenous wellbeing. Importantly, these two shifts reframed my conceptualization of the makerspace project and also opened spaces in which I was more likely to intentionally consider the unintentional filtering of Indigenous worldviews. Findings show that the factors that mediated the shifts (i.e., instructional conversations) were largely independent of tribal participation.

Nevertheless, one could argue that a direct, close, and continuous relationship with the PPN would have eventually resulted in the development of the required deeper understanding of important notions such as sovereignty and self-determination. When this shift took place, we had already held numerous meetings with the PPN and workshops with the community. While these interactions helped develop an in-situ contextual understanding and nurture the relationships between the UCB team and the PPN, my perception of an apparent disconnect between tribal sovereignty and self-determination and the makerspace project evidenced a potential gap. Deepening my understanding of sovereignty and self-determination might have naturally arisen though long-term immersion had it been geographically, economically, and academically feasible.

Design thinking scholars and learning scientists advocate for the importance of community participation in co-design processes. The former see it as a way to meaningfully understand community meaning-based needs, uses, and usability (Beckman & Barry, 2007; Buchanan, 2001; Giacomini, 2014) while the latter see it as a way of disrupting normative power dynamics and fostering transformative agency (Bang & Vossoughi, 2016; Gutiérrez, 2016, 2018; Gutiérrez & Jurow, 2016; Gutiérrez et al., 2020; Gutiérrez & Vossoughi, 2010). However, community participation alone may not be sufficient to ensure that Indigenous worldviews are consistently represented in the design process, especially when novice non-Indigenous designers have a predominant role in guiding that process. The above findings suggest that, without precluding community participation, such a sensitivity and appreciation can be developed through education and reflection on the part of non-Native researchers—work that can avoid placing additional burden on the time and energy of Indigenous community members.

Easing Tensions by Characterizing Shifts

Framing the shifts outlined in this chapter as questions begs for their resolution in the form of answers. While I cannot provide satisfying ‘answers,’ per se, I can describe how the shifts in my own thinking led to new forms of design and mutual relations of exchange. My aim in this continued self-reflection is to inform other researchers, especially novice, non-Native researchers in Indigenous-serving or STE(A)M-adjacent co-design work.

The data analysis shows slow shifts in my perspectives both about STEM fields and about sovereignty and self-determination. At the beginning of the PPN-UCB partnership, I thought that STEM fields were universally good and, therefore, STEM education would enrich anyone’s life (Figure 4.1a, Assumption). After engaging with decolonizing literature and understanding the undeniable Western legacy of STEM fields, I went through a ‘binary thinking’ phase that only allowed for the acceptance or rejection of such fields. I struggled to harmonize Indigenous wellbeing with traditional STEM education and saw STEM education as the instantiation of neocolonial agendas. Rejecting STEM education seemed to be the only way to advocate for Indigenous resurgence and wellbeing (Figure 4.1b, Shift 1). However, as time passed, I began to appreciate new levels of complexity. I started seeing adoption and rejection as the extremes of a spectrum (Figure 4.1c, Shift 2), and then began to transition to a bidimensional analysis that contemplated different levels of adoption and rejection along with different levels of criticality (Figure 4.1d, Shift 3). While these diagrams are simplistic and do not fully capture my current stance,³⁰ they do represent my shifting perspectives. Moreover, they respond to the call to make the “invisible visible” and to understand that “seeing” is socially situated and historically constituted (Gutiérrez, 2018).

³⁰ Eventually, I adopted a more nuanced perspective centered on onto-epistemic navigation (Medin & Bang, 2014a) as a way to support Indigenous wisdom and wellbeing without disregarding the contemporary necessity and usefulness of STE(A)M fields.

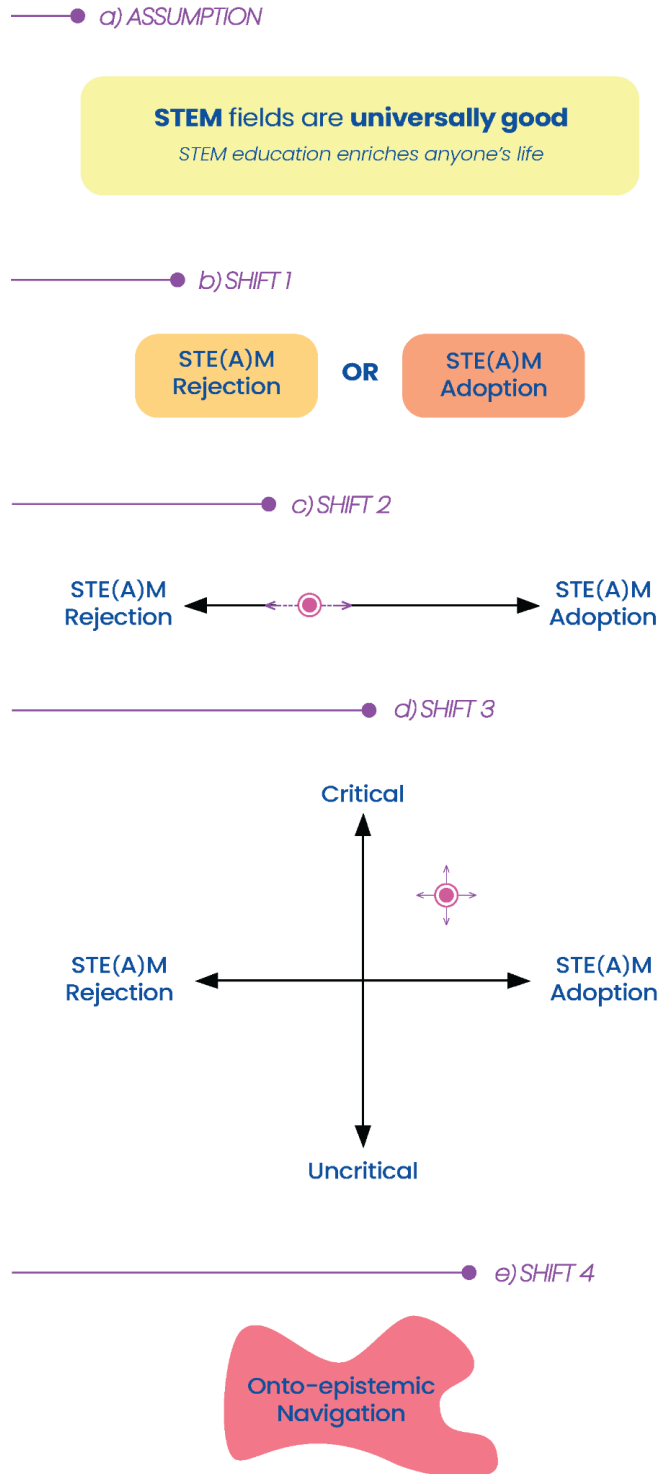


Figure 4.1. Shifts in my perspectives about STEM fields

My views on the role of sovereignty and self-determination in the makerspace project also shifted gradually. Although I initially failed to see the connection between what I saw as two merely legal notions and a STEM educational space, their relevance became clearer when the framing of the

makerspace changed from being *STEM-centered* to *wellbeing-centered*. In late 2018, after my conversation with Dr. Derrika Hunt, I interpreted tribal sovereignty and self-determination as elements to be left alone. Thus, I wondered whether I, as a non-Native person, was entitled to have a role in the project, and if so, which role would that be. It was only after several months that I made peace with being part of the PPN-UCB partnership based on initiation of the PPN-UCB relationship by the tribe (Shelby, 2013).³¹ Thanks to the two courses taught by Dr. Lima, I also came to understand that there is no universal agreement on the definitions of sovereignty and self-determination, and also to appreciate the implications of this ambiguity: the embodiment of such notions can differ from tribe to tribe.

In sum, I have come to understand that decisions regarding STE(A)M educational initiatives ultimately remain in the hands of the Native Nations themselves. As history shows, it is not adequate to say “I (as an external designer) know *this* is better for you and your people.” It does not matter whether the *this* is framed under dominant perspectives (e.g., ‘STEM fields are fundamental for the future success of Native youth’), under a framework of decoloniality (e.g., ‘STEM education is subservient to neocolonial agendas’), or something else. Sovereign nations should decide what is best for their peoples.

I am not suggesting that external designers do not need to envision and develop their own perspectives. In fact, I believe it to be essential for designers to have a clear sense of their design sensibilities and principles. However, considering these perspectives raises the question: What if the tribe’s perspective does not align with one’s own design sensibilities? This work suggests engaging in respectful, continued, and authentic dialogue during the planning phase of the project (see Chapter 3 to better understand the necessity of having a planning phase). This dialogue should entail making tensions visible, attending to and negotiating them collaboratively, and deciding how to proceed. Tackling differences and contradictions can be seen as moments of Freirean generative and dialogical conversation rather than obstacles, and opportunities for mutual learning and growth. Potential options could also include changing the composition of the core design team by recommending other designers whose views better align with the tribe’s, or even stopping the project altogether.

Engaging with Macro, Meso, and Micro Questions

Understanding the close relationship between sovereignty, self-determination, and Indigenous worldviews enabled me, a novice non-Indigenous researcher, to acknowledge, critique, and rethink many of my assumptions at different scales. Specifically, I found engaging with macro, meso, and micro level questions (M-questions) to be a helpful design method. Defining such questions is an important exercise in situating ourselves in the design/research space, and engaging with these questions helps us to better understand ourselves.

In the case of the makerspace project, I started at a micro level questioning the importance of STE(A)M education (Figure 4.2a). Answering this question required me to zoom out to consider the aims of education more generally (Figure 4.2b). Contemplating this meso-scale question prompted me to zoom out yet again to think about the kind of life, society, and world I envisioned this work contributing to (Figure 4.2c). It was only after reflecting on this macro-level inquiry that it made sense to revisit the smaller-scale questions, now reframed around the contributions of education in general and STE(A)M education in particular to creating and sustaining that envisioned life, society, and world (Figure 4.2d). Importantly, this work of reframing opens space for community perspectives (i.e., what

³¹ While being reflective about one’s role in this kind of project is necessary, I have concluded that taking the reflection to the extreme can lead to a paralyzing effect that can also undermine tribal sovereignty.

kind of world the community envisions³² and how education in general, and STE(A)M education in particular, can contribute to the making and sustaining of that world) and increases the likelihood of non-dominant worldviews being represented in the design. Figure 4.2 shows how engaging with M-questions can be thought of as a design strategy to better understand ourselves and non-dominant worldviews.

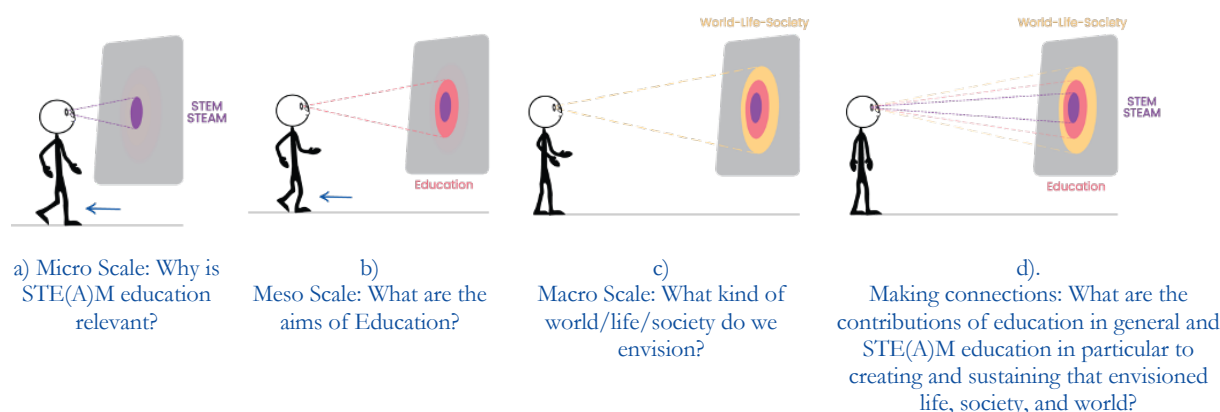


Figure 4.2. Engaging with M-questions as a design strategy.

Conclusions

I started this chapter by introducing the research questions that I later addressed using chronological sequencing. I then presented two main shifts in my thinking while I was part of the makerspace project. For each shift, I shared the event (or critical incident) that evidenced the existence of that change and then summarized the factors that mediated it. In the discussion, I reflect on how each shift speaks to the commitments of learning scientists and design thinking scholars to community participation in co-design projects, especially when working with non-dominant communities. The findings of this chapter suggest that *while community participation remains essential in a co-design process, it might not be sufficient for the resulting design to be rooted in the community's worldview*. In this case, the particular division of labor in the makerspace project, combined with the nature of the shifts and concomitant design decisions, had the potential to filter the community's ways of being, seeing, and making in the world. Therefore, I argue for continued education and reflection by non-Native researchers, a process that can be aided by a micro-, meso-, and macro-level exploration exercise. Such work should be conducted in close conversation with community input but can and should also proceed outside of community members' time. Furthermore, this case study shines some light on the importance of novice non-Indigenous designers engaging in activities that do not involve community but are linked to the population (e.g., courses, conferences, museum visits, etc.)

Finally, I suggest that, in co-design processes with Indigenous communities, enacting self-determination should involve at least two components: a) the meaningful participation of the community—which will have different kinds of instantiations depending on the context and unfolding

³² Variations on this question could be: What kind of world does the community want to live in? What sort of world does the community want to make and sustain? What kind of life do community members want to live? What are the most important qualities (values) the community intends to live by?

activities—and b) external designers learning to see the world, be in it, and act in new ways based on their new forms of perception and understanding (Bang & Vossoughi, 2016; Ingold, 2001). Addressing these two components in a process that is mainly guided by external and novice designers increases the chances of the final design being guided by the community's worldview.

Chapter 5

Introduction

Having described and discussed the chronology and the design tensions in the project in the previous chapters, I now turn to a discussion of the community's own conceptions of wellbeing and STEM. Understanding how the community conceives of these notions is essential to creating the foundation for the co-design process, which consists in developing a shared vision of what STE(A)M and wellbeing mean. Not engaging in this baseline process could entail filtering key perspectives from the beginning. For example, assuming that the tribe and the non-Indigenous researchers share a common understanding of wellbeing tacitly privileges the normalizes a Westernized perspective—that is, a definition based on a medical model of health that links wellness with the prevention or absence of illness or disease (i.e., dysfunctions in the body)—a more narrow conceptualization of wellness than that embraced by many Indigenous communities (Bourne, 2010; Hodge, Limb, & Cross, 2009; Weaver, 2002).

In this chapter, I review the guiding research questions before detailing the data analysis protocols followed in this case. I then present the findings of this analysis drawn from 20 interviews with Native American peoples and one non-Native person who were affiliated with the PPN. Findings are organized according to three main topics: wellbeing, perceptions of STEM/STEAM, and issues at their intersections that emerged from participants' narratives.

Briefly, most participants described wellbeing as linked to notions of balance, spirituality, and wholeness. Additional themes within this topic, often used to motivate and promote wellbeing in the community, included cultural connection and identity as well as healing from historical trauma. Perceptions of STE(A)M included links to ancestral wisdom and practices. Importantly, some participants emphasized both subtle and stark differences in their nature. Some saw advantages to bridging the traditional and STEM worlds together, while at the same time being aware of potential constraints. In general, STE(A)M education was perceived as a current necessity both as an environmental sciences approach to improving tribal stewardship of the Land and as a path for youth to prepare for the future.

The discussion and conclusions summarize, at a high level, participants' perspectives on wellbeing, STE(A)M, and their intersections and tensions. I also share some challenges encountered in working to document and understand perspectives rooted in worldviews distinct from my own. These challenges are likely shared by others designing and researching for STE(A)M learning in other Native communities specifically and, more generally, by those working to acknowledge and genuinely engage with worldviews unfamiliar to them. I propose that, by entangling and juxtaposing the topics of wellbeing and STE(A)M, we can both honor connections to ancestral wisdom and practices valued in these communities and acknowledge the ways in which these two worlds are distinct and irreducible.

Research Questions

The research questions guiding this chapter are: *What are participants' perspectives around the topics of wellbeing and STE(A)M?* (RQ3a) and *What connections, if any, do the participants see between these two areas? Conversely, what tensions emerge?* (RQ3b)

Data Analysis

This chapter draws on 21 semi-structured interviews I conducted. All participants were somehow connected to the PPN, be it as citizens, as administrative staff or their relatives, or as participants in the tribe's activities. All but two participants identified as members of one or more of the 12 different tribal nations connected to the PPN. Pinoleville and Redwood Valley Rancheria were the most highly represented, comprising 20% and 12% of the interviewees, respectively. Capturing perspectives held by different age groups was essential, as promoting and nurturing intergenerational interactions became a central feature of the makerspace. Therefore, as mentioned in Chapter 2, recruitment continued until all groups were represented. Sixty-two percent of the participants were women. For the individual information on all participants, please refer to Appendix 5A. Recordings totaling 1434 minutes (23 hours and 54 minutes) were then transcribed: 1117 minutes by me and 317 minutes by a transcription service.³³

Cleaning, coding, and analysis were completed using the MaxQDA data analysis software. Interview transcripts were analyzed with a dual-pass coding technique (Saldaña, 2021). Transcripts were first coded along the major themes derived from the interview guide. In the second pass, data coded segments of the first pass were analyzed for patterns across participants. Themes within the topic of wellbeing included defining wellbeing, promoting it through cultural connection and identity, and its value for healing from historical trauma. Within the topic of STE(A)M, themes included comparisons and contrasts to ancestral wisdom and practices, intersections of culture and STE(A)M, and a perception of STE(A)M education as necessary both for land stewardship and for preparing youth for the future.

In the findings section, I introduce each theme with a quotation to illustrate it in participants' words, and then present significant and representative quotes and views on each sub-theme (see Table 5.1).

Table 5.1. Topics and themes from the data analysis

First Pass: Interview-based Themes	Second Pass: Cross-participant Sub themes
Wellbeing	Defining wellbeing
	Cultural connection and identity
	Historical trauma and healing
STE(A)M	Before STEM, Other than STEM
Intersections of wellbeing and STE(A)M	Two worlds coming together
	Creativity, art, and expression
	STE(A)M as a current necessity
	Concerns

³³ I reviewed the transcripts generated by the service to ensure accuracy.

Findings

Within the interview topics of wellbeing and perceptions of STE(A)M, participants shared a range of responses, with consistent patterns documented in the themes discussed below.

On Wellbeing

“It just means like you’re well-balanced, you’re well healthy, your mind is healthy, you have a healthy body, you’re spiritually strong. That’s the same to me if you’re in your culture.” [47-year-old man, Scotts Valley Band of Pomo Indians]

Participants were prompted to share whatever came to mind when they thought about wellbeing. Answers, as expected, were varied. Most teenagers limited their answers to a specific kind of feeling (e.g., happy, peaceful). However, one 15-year-old explained that wellbeing cannot be captured by one word. He briefly talked about one’s identity and being able to fully express it, and then concluded by simply saying that to him, wellbeing meant “being comfortable with your own thoughts and feelings” [15-year-old teenager, Coyote Valley Band of Pomo Indians]. Many adults referred to wellbeing as a state of being balanced and healthy, and brought up at least one of four dimensions: mind, emotions, body, and spirit. In contrast to the two previous groups, almost all Elders, without hesitation, *linked wellbeing to culture*. Despite these variations by age, three themes emerged across most participants: 1) wellbeing as connectedness, balance, and spirituality; 2) fostering wellbeing through cultural connection and identity; and 3) healing from historical trauma as a precursor to wellbeing.

Wellbeing as Connectedness, Balance, and Spirituality

Connectedness, balance, and spirituality came up as components of wellbeing. Participants talked about connectedness in multiple ways, ranging from connections with the Creator to deep connections with one’s identity. In particular, connections with culture emerged as profound and life-defining, as shown in this quote by a basket weaver: “[Culture] gives me a purpose and a reason. For me there’s no other way to live” [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria].

This excerpt, like many others, implies that culture, for this woman, is not a mere “add-on” to her life, but a meaning-giving element that is tightly connected to wellbeing. Similar quotes were found in many interviews, in which culture was described as “giving you roots” [53-year-old man, non-Native], “bringing wellness inside you [54-year-old woman, PPN],” “tugging at your heart and spirit,” and its absence described as causing “a hole in your life” [47-year-old man, Kashia Band of Pomo Indians].

For some interviewees, having a deep cultural connection through spirituality is exactly what enables balance:

If you’re not well, that’s the place that you go to: it’s your culture. The dancing, or the prayers, the talking circles. [It’s] a place where you can get reconnected to the Creator or even just your community. So that you can feel loved and supported.
[27-year-old man, PPN]

The 27-year-old male quoted above exemplifies the association between wellbeing, culture, and connectedness. Other participants similarly linked wellness to a sense of collective experience (e.g., “wellbeing is being with people that are going through the same things” [51-year-old woman,

Sherwood Valley Rancheria and Yokayo Rancheria], or “getting reconnected to your community” [27-year-old man, PPN]), and to a feeling of belonging. The views shared by the interviewees allow me to conclude that the wellbeing of an individual is dependent on the wellness of the community/tribe.

Fostering Wellbeing through Cultural Connection and Identity

When asked about potential relationships between wellbeing and culture, many participants described cultural connection as a foundation of wellbeing:

People that I know that are in their culture, they seem more relaxed, more balanced, and they're not stressed out. It's almost like no worries or something. I know everybody's got worries and things that they... But it's the way they handle it. [47-year-old man, Scotts Valley Band of Pomo Indians]

When talking to an Elder and her daughter, both of them culture keepers, the former shared that to her these two notions were “one and the same” [70-year-old woman, Redwood Valley Rancheria]. The daughter then explained that “[their] culture is set up for wellness” [42-year-old woman, Redwood Valley Rancheria]. Participants talked about how engaging with different cultural practices helped them to be well. While praying, dancing, and singing were frequently mentioned, other activities such as making regalia and baskets, or having access to traditional foods and medicines were also brought up.

While many interviewees emphasized active participation in cultural activities, for some participants a passive engagement was equally meaningful. A 17-year-old teenager shared that while “making baskets or making regalia doesn't really give [him] peace,” watching people dance has a great impact on him. “When I'm watching people dance, I kind of feel peaceful, like everything is good in the world, I'm not worried about nothing else” [17-year-old teenager, Coyote Valley Band of Pomo Indians]. Similarly, a 51-year-old basket weaver said that “just watching the Pomo dancers [...] it's just a release of stress, not thinking about bills or everyday life that we have to live in the non-Native community” [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]. Finally, one of the Elders mentioned that “Watching my kids or grandkids participate in cultural activities, whether it is our Big Time or [...] I can sit there and enjoy myself” [70-year-old woman, PPN]. It seems that, whether actively constructing or more passively observing, participation in cultural practices is a well-spring of wellbeing for the interviewees.

Healing from Historical Trauma as a Precursor of Wellbeing

As the interview progressed, I also invited participants to think about historical trauma and its potential connections to wellbeing and a need for healing. Participants' responses positioned the complex origins of cultural disconnection within both the genocidal goals of the government and well-intentioned familial efforts to protect them from that violence.

[My dad said] “the government [...] wants us not to teach you the language, the culture. You wanna be, he didn't say assimilated but he meant [...] I think he said [...] you have to get along with the people in town.... So, I can see why they [her Elders] don't want to talk about it, because I imagine it probably was a lot of hardship for them. [...] They just wanna try to keep you safe and move forward not realizing that it's gonna really hurt you not knowing your culture. Not knowing anything about your ancestors, will really hurt you in the long run. [70-year old woman, PPN]

While recognizing their Elders' efforts to "keep [them] safe" and avoid hardship they had experienced, this Elder identified significant harm resulting from cultural distancing.

During another interview, a 27-year-old reminisced on his own story and then explained that not knowing about historical trauma might be dangerous, especially for young people. He thought that openly talking to youth about this topic ("someone who's very close to you, not long ago, went through traumatic experiences") might help them understand why they are feeling what they are feeling,

So, I think as long as people are explaining 'okay, this happened, and the reason you're feeling so angry is kind of like it happened to you, you weren't there but it's just passed down like that. So, that's why you're still feeling mad but it's important that you figure out how to move past that and then what you can make to make yourself and your family better.' [27-year-old man, PPN]

Both for those who experience it directly and for their descendants, historical trauma leaves a lasting mark. Therefore, having spaces where youth can acknowledge and heal from historical trauma is central to the whole community's wellbeing.

STE(A)M

"You are talking about science, we're talking about the sky, and the earth, and the water, and the earth, and how all related to us." [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]

Having reviewed participants' perspectives on wellbeing, I next characterize their perspectives of STE(A)M before discussing the two topics in interaction.

Before STEM, Other than STEM

Participants shared the view that science, technology, engineering, and mathematics were present in Indigenous communities *before* the 'invention' of STEM, a view that manifested in many ways. When asked whether they saw any connections between their cultures and STEM fields, several participants did not hesitate to respond affirmatively. They expanded on their answers by making an explicit connection to their ancestral heritage, whether referring to the environment or to the wisdom and practices of their ancestors. Furthermore, STEM was repeatedly referred to as a term that did not exist back in the day but in some ways represents what they were already doing. Take, for example, a quote from a basketmaker with heritage from Sherwood Valley and the Yokayo Rancheria, whom I interviewed at the 2019 cultural camp:

...environment is culture cause we're out here in the environment right now, and this is where we used to live. This is our tradition; this is our culture. This is our land. And environment, science, technology, engineering, art and math those are just all modern terms for what Indian Country was. [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]

A strong sense of pride was evident in how various interviewees portrayed their ancestors as wise and knowledgeable peoples "who were practicing that before it became STEM" [54-year-old woman, PPN]. For instance, a 53-year-old non-Native person who is father to three self-identifying Native Americans stated that, "Like our ancestors [from Central America], the Pomos were mathematicians, so they were good at math. And then, all the things they did, the baskets, everything

they made. I mean they had to” [53-year-old man, non-Native]. Along the same lines, a 14-year-old Native American teenager with no tribal affiliation emphasized that “[w]e were doing math here as Native Americans when white people showed up, and we gave them knowledge” [14-year old teenager, no tribal affiliation]. An Elder provided more concrete examples about things that colonizers did not know about before they got to ‘the New World’: “[W]e’re the ones who understood the importance of a circle, and also understood the value of the zero [...] the Mayan calendar is one of the most accurate calendars ever done, and you know, we still don’t use it” [62-year-old man, Big Valley Band of Pomo Indians]. Many other interviewees were aware that Indigenous peoples’ achievements “before STEM” existed as such. A 35-year-old PPN citizen declared that,

Our ancestors were researchers. They were mathematicians [...] they had everything figured out for thousands and thousands of years. New western science and everything, I don’t feel like it’s that advanced. I mean they have the machines, and they have the technology but if you come from our ancestral backgrounds [...] they knew what plants grew, where they grew, how to use them, when to use them. I mean they did the cultural burns, they knew how to manage the land, and navigate the seasons, everything. And so, when it comes to science and engineering, I feel it’s a part of who we are, to like [to] discover and it’s like in our DNA already. [35-year-old woman, PPN]

Another interviewee, a 40-year-old male from Round Valley, made a concrete connection between original technologies and what currently would be called engineering specifications. He mentioned that all tools, whether for cooking, cleaning, or hunting had very specific requirements and constraints, such as size, shape, flatness, and sharpness. This person also mentioned that he did not think this was how it works today. His comment “I guess it’s the same but it’s two different ways” [40-year-old man, Round Valley] points to how ancestral wisdom and practices are separate from or ‘other than’ STEM.

For some participants, what is nowadays called STEM and STEM-related ideas were understood quite differently by Indigenous communities before colonization. Take, for instance, another quote from the interview with the previously mentioned basketmaker:

We didn’t have those words before because there was no such thing. To me those words were used in different ways. You are talking about science, we’re talking about the sky, and the earth, and the water, and the earth, and how all related to us. And technology was for us just going out and making our own tools out of the Earth [...] [it] was provided for us through the Earth. [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]

The way she refers to the sky, the earth, and the water points to the transdisciplinary nature of Indigenous wisdoms, and also to the importance of the relations in Indigenous worldviews.

An Elder from Big Valley also touched on this issue by keenly pointing out underlying philosophical differences between traditional Western perspectives and some Indigenous worldviews. He explained that while resource extraction is embedded in the Western mindset and concomitant STEM fields, tribal cultures understand nature and the universe differently:

I think the Western idea of science, technology, and mathematics has a focus on resource extraction, whatever that resource is. [...] That’s the focus of the western mind. In a tribal cultural mind those [resources] are not separate and not unimportant. When we think about nature, it’s a [...] whole different philosophy

of what that represents to us. [...] we understood the universe in a different way [...] But again, we had stories that connect it to the stars, about the big dipper, and the bear and all kind of different things that we see in the sky as well. [62-year-old man, Big Valley Band of Pomo Indians].

Again, we can appreciate a stark contrast in how the natural world is conceptualized from Indigenous and traditional Western perspectives, and the repercussions that such views have on how peoples interact with the natural world.

Another participant, a 54-year-old PPN citizen, also touched upon this divergence by emphasizing that no matter the activity her ancestors engaged in (hunting or basket weaving, for example), they “never took more than they needed” and “whatever they took they made sure it’ll grow back or be replenished” [54-year-old woman, PPN]. In contrast to these practices of co-existence, she linked resource extraction and STEM fields with notions of mastery and ‘getting ahead.’

Taking the two parts of this theme together, participants viewed cultural wisdom and practices as, on the one hand, reflecting STE(A)M concepts and competencies long before the field even had such a name, and, on the other hand, reflecting vastly different values and worldviews than those typically associated with STE(A)M disciplines. As I illustrate below, participants depicted these overlaps and tensions as a coming together of two worlds.

Intersection of Wellbeing and STE(A)M

‘Science makes me think of our earth, the land, the sky. I look up and I see nature. I think of the trees. I think of where we live. I think it encompasses all that, and even the people that are walking around.’ [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]

Community members’ perspectives about potential connections between wellbeing and STEM are multifaceted. This pairing was seen by some community members as a possibility for the coming together of two worlds. In particular, both STE(A)M and cultural practices were seen as promoting creativity. Participants also viewed ‘STEM as a current necessity’ both for culturally-valued land stewardship practices and for youth’s future. However, potential conflicts between STE(A)M and tribal wellbeing were also raised.

Two Worlds Coming Together

The idea of worlds coming together was expressed by some adults as they described how they saw their culture and STEM as connected. Both affordances and constraints were discussed. A 47-year-old Kashia leader emphasized how STEM knowledge could be enhanced by traditional knowledge, and vice versa. He pointed out that,

... it goes back to us [...] being stewards of the Land, stewards of the Air. We’re given these things, these are gifts and if we keep polluting them [...] we’re going to be stuck with nothing pretty soon. And that’s where, I think, culture and STEM [...] come together, that knowledge that was first handed down to the people, and then being enhanced with more knowledge [...] So, they both really go hand and hand. [...] [47-year-old man, Kashia Band of Pomo Indians]

To him, thinking about the intersection of culture and STEM is a necessity for Native American peoples to be able to fulfill their roles as stewards of the land, a topic that will be further discussed in the next section.

Similarly, a 35-year-old PPN citizen explained that bringing the two worlds together would positively broaden perspectives. To her, notions of alignment, balance, and harmony were the main point of connection between Native perspectives and STEM. She was excited by the idea of providing “extra proof” to people by being able to say “creation stories say this, and then also STEM says this.” In the end, she mentioned that it would be “twice as better” [35-year-old woman, PPN].

While the previous participant did not see tensions between creation stories and STEM, for a few people creation stories and spirituality were, potentially, points of tension—particularly with science. An Elder and medicine woman, after thinking for a bit, talked about potential conflicts with the “spiritual world, Indian world, doctoring world” because scientists do not believe “we see spirits, they do not believe in the Creator” [Elder woman, Yorkville and Yokayo Rancheria]. The same Kashia leader I quote at the beginning of this section shared how he, personally, felt that in the past science completely disregarded ancestral knowledge (“No, no. no. You’re wrong!”), and then elaborated on the conflict, saying that he feels,

We have creation stories. [...] for us Kashia [...] men stepped out of the water. And there’s a story behind why they did so and came on to dry Earth. Pretty long story. But those are our stories, and our tribes have stories all the way across the board like that. But then science came out and said “No, there was a big bang and we came into existence” [...] I have such a hard time with that [...] I want people to tell me that I came from the Creator who looked down on this void and said this is what I want it to be. [47-year-old man, Kashia Band of Pomo Indians]

As these examples illustrate, some participants identify tensions between Native and scientific narratives, tensions that are not unique to Native American communities.

Finding Commonality in Creativity, Art, and Expression

For many participants, the most obvious connection between their cultural practices and STE(A)M fields was creativity. A 35-year-old woman from the Paiute Shoshone tribe talked about technological advancements and how even ‘creating a better phone’ requires creative people [35-year-old woman, Paiute Shoshone Tribe]. A 15-year-old teenager from Coyote Valley explained that when one engages in certain cultural practices—such as making regalia—and in STEM one needs to ‘think outside the box’ to create unique things [15-year-old teenager, Coyote Valley Band of Pomo Indians]. Other interviewees brought up basket making and beading to exemplify links between STEM and their culture. For both of these cultural practices, geometry and its connection to the design of patterns, as well as counting, are important to making sure that ‘your shape is going to come out in that round object’ [46-year-old woman, PPN]. Arguably, then, the role of STEM in these practices could be seen as supporting wellbeing, given the strong links between such cultural practices and wellbeing documented above.

People frequently emphasized the art component of STE(A)M thanks to its potential to open spaces for expression. A young adult from Round Valley who works with youth noted,

Some people don’t like to talk about their feelings [...] When you don’t express them they stay bottled up in you and at any point you can snap, you could break (brief pause) Anything from fighting, suicide, substance abuse. All that is a ticking time bomb [...]. So to be able to get those emotions out, and to me through art is just a beautiful way ‘cause you’re creating this beautiful visualization that it’s just very powerful. [23-year-old woman, Round Valley Indian Tribes]

It seems that the expressive possibilities of art create opportunities for sharing and releasing emotions valuable for the wellbeing of community youth.

STE(A)M as a Current Necessity

Many participants shared a perspective in which STEM is necessary for meeting two community goals: maintaining stewardship of the Earth and preparing youth for the future.

To Become Better Stewards of the Earth

Some of the interviewees, all of them adults, linked STEM fields to a capacity to fulfill their roles as Stewards of the Land. For example, a PPN tribal council member explained that “we’re always trying to protect waterways, the ocean, the gathering that we do of our traditional foods” [46-year-old woman, PPN]. Seaweed and abalone,³⁴ both cultural staples, were brought up to illustrate the potential connection between their stewardship and the sciences. The gathering of both natural resources is currently regulated by public policies because of their endangered status. Interviewees explained that this situation has many root causes including bad harvesting practices (e.g., scraping the rocks so the seaweed doesn’t grow back anymore), greed (i.e., people taking too much), and other natural phenomena as exemplified in this next quote from the Kashia leader,

[...] we have a huge problem with the Abalone, the red Abalone, we’re losing that. There’s a huge influx of purple sea urchins and we’re losing our kelp beds, our ocean forest. So, for us that’s a big deal because that’s part of our culture as well. Our food, our diet, our connection to the Earth, our stewardship [...] that was placed into our hands, that was ripped out from our hands. But you know what? [It has been] given back to us again. I love that. Full circle. It’s so beautiful! [47-year-old man, Kashia Band of Pomo Indians].

In this way, this leader identifies the complex ecology underlying the decline of the red abalone as well as the joy of cultural stewardship practices.

Other adult interviewees pinpointed the necessity of engaging new generations in STEM fields because of the current environmental crisis. A 54-year-old PPN citizen referred to global warming and the melting of glaciers and concluded that, “That’s why we need our young people in the sciences” [54-year-old woman, PPN]. A basketmaker expressed the potential—not certainty—of STEM being beneficial “if we had some people learning about ways to improve the environment, the ocean, to bring back abalone” [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]. As the next section illustrates, participants also emphasized STEM as important for youth in preparing for their economic future.

To Get with the Times

“Nothing is stagnant, everything is changing” was how a 35-year-old participant from the Paiute Shoshone tribe started to describe the value of STEM education for Native youth. She continued, “The engineering, the mathematics, the technology needs to start being played and interwoven into the culture because with the ways things are going we need to be able to advance but also maintain that cultural resilience” [35-year-old woman, Paiute Shoshone Tribe]. An Elder mentioned that she

³⁴ Abalone are marine gastropod mollusks that fulfill both a ceremonial and an alimentary function for many tribes of the area.

would like children in the community to study STEM “because that’s what the world does. It’s what they should be learning. Education and culture together, go hand in hand” [70-year-old woman, PPN]. In the same breath as they express a need to stay current, these participants also underscore the importance of the continued connection between current education topics and heritage cultural practices.

When asked about why they thought STEM had gained so much prominence in the last decades, many participants’ answers revolved around technology and its connection to the job market. A 15-year-old teenager thought that “technology offers a lot of jobs,” and that youth could “use tech to their advantage” to “be ready to face the future” [15-year-old teenager, Coyote Valley Band of Pomo Indians]. Facing the future for some participants entails getting a stable job, which in turn implies understanding that the way the world is moving is inexorably linked to rapid technological advancements. A 27-year-old PPN citizen noted that many things are getting automated and that “if you want a job that pays you something that you can live on, you probably will have to know how to do something with the computer” [27-year-old man, PPN]. While he did not see this kind of future as promising, to him the real power of STEM education for youth was to show them different ways of seeing things and solving problems. A 46-year-old PPN citizen reflected on the speed of technological advancements: “Everyday something new is invented. It’s kind of like a competition. Who has the best? Who has the biggest, the fastest? (brief pause) and it’s about making money” [46-year-old woman, PPN]. While she does not care for technology, she acknowledges its importance and constantly encourages her teenage children to “pick a career that a computer can’t take over.” Thus, participants seem to view STEM and associated technologies as opening up career opportunities at the same time as they threaten others or shift priorities in problematic directions.

One of the basketmakers offered a quite unique perspective on the importance of STEM education by framing it as a potential resource for engaging youth in cultural practices. After describing STEAM as the study of the environment, she shared that some youth might see cultural practices as burdensome, saying,

... when you talk [...] to the young kids [about] traditions and culture maybe [it] scares them off because, maybe, they think it’s too much work. Going out to the wilderness to gather and process, or whatnot. But when you put it in STEAM terms, maybe they’re thinking of classrooms and books and professors, you know. [51-year-old woman, Sherwood Valley Rancheria and Yokayo Rancheria]

Though incompletely, this response suggests the potential of STE(A)M to help new generations connect with their cultural and traditional practices. She suggests that using the vocabulary children are exposed to daily in schools—what she calls STE(A)M terms—might prevent youth from feeling overwhelmed about cultural practices and instead recognize them as something related to their experiences from formal schooling.

Concerns at the Intersection of Wellbeing and STE(A)M

In addition to the possibilities raised by the intersection of STEM and wellness, participants also mentioned some concerns. One Elder expressed concern about the wellbeing of youth and the priorities, as he sees it, of current STEM education. He explained that “one of the tragedies of STEM right now” is how STEM education over-emphasizes mechanics and neglects philosophies:

[So much] focus on STEM may be unhealthy for the young minds. I don’t know. That’s not my job. But to me, some of the biggest ideas are not necessarily about STEM. And so, a lot of the focus in education, and certainly in STEM, isn’t about

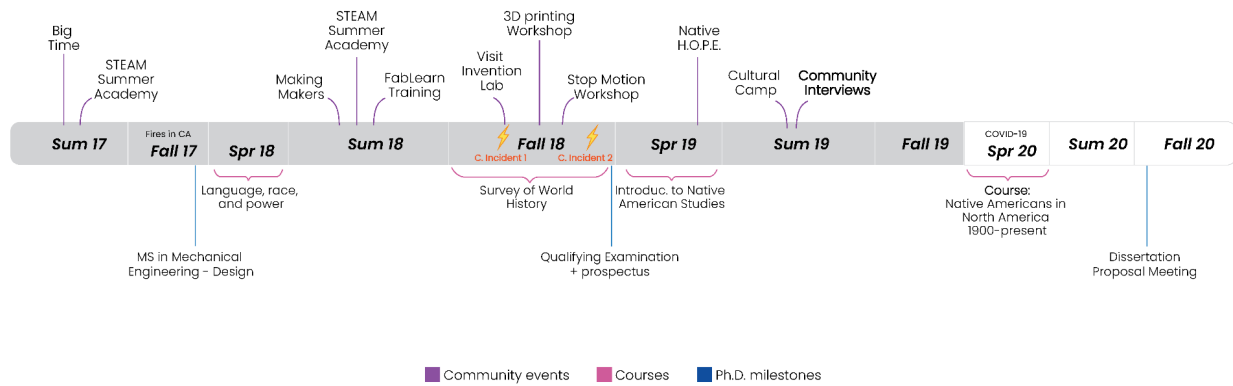
the philosophy of those things. It's about the mechanics of it [...] if you understand the philosophy [behind math, for example] oh my gosh! it becomes a bigger world. [...] There isn't a cohesive philosophy on how it [STEM] helps the community [...] [62-year-old man, Big Valley Band of Pomo Indians]

To this Elder, the priorities of STEM education do not best support youth's ability to think about and understand their worlds. This Elder also mentioned that the goal (in his words, "the big diamond" of STEM education is getting a "great job." However, to him it is clear that "there's way more to life than a good job." Relatedly, the same 27-year-old PPN citizen who had mentioned that getting a decent job might require knowing how to use a computer also thought that an intense focus on STEM could be "a double-edged sword," especially if youth start feeling that STEM is the only way to be successful. He explained that "before STEM was a thing" people would say that you had "to go to college if you want to be successful," a perspective he does not share. He felt that while the discourse has not changed, the target is now more specific: STEM. He worried about people being left out in the future because not everybody is good at STEM and because there are people who "don't want to do that" or are not "meant to do so." In this sense, the focus on STEM as providing career opportunities could put the field at odds with community members' wellbeing.

Discussion

The critical incidents described in Chapter 4 (Figure 5.1, in orange) triggered a reflective process that allowed me to challenge and reframe the constructs around which the makerspace project revolved. Comprehending wellbeing, STE(A)M and Making from the PPN community's perspective became a central concern. However, as Figure 5.1 shows, at the time I conducted the interviews (Summer 2019) some of the personal shifts I described in Chapter 4 were still taking place (e.g., I audited the course 'Native Americans in North America from 1900-present' in Spring 2020). Therefore, the semi-structured interview protocol and the actual interview discussions did not capture some aspects that later became central to my conceptualization of the project. Particularly, I learned about the framework 'Holistic Ecological Perspectives' (Begay, 2020) in June 2020 during a CoInFEWS workshop.³⁵ The impact of this new perspective on the interpretation of the interviews (as presented in this chapter), as well as on the makerspace project more generally, will be explored in Chapter 6. In this section, I examine the interview data, dive into the main findings, and discuss how they guided the reframing of the makerspace project, preparing for the basketmaking case study described in Chapter 6.

³⁵ The CoInFEWS workshop was organized by UC Berkeley, the University of Arizona, the University of South Florida, and Diné College to determine how institutions of higher education can collaborate with Indigenous communities on innovations at the nexus of food, energy, and water systems. It was originally to take place at Diné College, on the Navajo Nation's reservation. However, because of COVID-19, it transitioned to a virtual format.



Wellbeing

While perspectives around wellbeing varied, the community clearly sees wellbeing as closely tied to a sense of connectedness, balance, and spirituality. Furthermore, more specific views aligned well with Weaver's (2002) description of Native wellness:

- **Wellbeing is a holistic construct**, conceived differently than a mere “absence of disease.” Native American views on this notion do not necessarily consider the body-mind split found in Western thought (Weaver, 2002). Rather, mind and body are complementary aspects of the whole, and a problem in one will cause a lack of wellness in the other.
- **Native wellbeing emphasizes the community and not the individual.** Responsibility and respect for others is a capstone of Native wellbeing. That is, the wellbeing of an individual is dependent on the wellness of the community/tribe.
- **Relational worldviews and spirituality are pillars of wellbeing.** Wellbeing is imbued with a sense of reciprocity, and responsibility to maintain balance between the natural and spiritual realms.
- **Wellbeing is rooted in culture.** A strong sense of cultural identity reinforces wellbeing. Forced assimilation through boarding schools and outlawing of cultural and spiritual practices still has a strong impact on the historical trauma of Indigenous communities. Community members mentioned that fostering wellbeing requires acknowledging historical trauma and also providing opportunities for healing. Weaver (2002) rightfully points out that most non-Native efforts to promote Native wellness are based on Western values and philosophies, and that promoting Indigenous wellbeing entails that communities stop being characterized by others and rather retain the ability to define and name themselves.

These elements from the interviews motivated me to critically examine the original design process and identify many points of divergence between my initial views on wellbeing and what the interview data revealed. Initially, I saw wellbeing as an individual phenomenon that could be equated to being healthy. Therefore, I envisioned using the makerspace to create inventions that privileged individuals embedded in a social context. For example, the curriculum of the 2017 STEAM Academy Robotic workshop emphasized the wellbeing of individual children and their family members; however, in essence, it failed to capture the communitarian nature of Indigenous views. The data and findings presented in this and the previous chapter show how broader reconsiderations of cultural aspects (i.e., better understanding Indigenous worldviews by contrasting them with Western perspectives) along with a deep dive into the tribe's culture were crucial to reframing design decisions

even around ideas—such as wellbeing—that I had initially considered unproblematic. Again, as (Weaver, 2019) asserts, balance, spirituality, and wholeness of individuals, families, communities, and nations are all facets of Native wellness—aspects mostly absent from the initial conceptualizations of the project. Thus, the promotion of Native wellbeing in the context of the makerspace project should encompass both reclaiming cultural values and activities and providing opportunities for healing from historical trauma. One design possibility that emerges from the findings of this chapter, specifically the challenges that some people experience verbalizing emotions, is to use the creative arts as an avenue for expression and healing (Herring, 1997). For example, the Theater of the Oppressed (Boal, 2014) is a powerful tool for reenacting historical and personal events in ways that free repressed emotions.

STE(A)M

A second finding from the interviews was the role and significance of STE(A)M. Many participants emphasized that, although STE(A)M did not exist in Pomo languages, science, technology, engineering, and mathematics were present in Indigenous communities before the ‘invention’ of STE(A)M. An implication for design is that an Indigenous makerspace, for example, should acknowledge ancestors as scientists, engineers, artists, and mathematicians to counteract historically dominant narratives of Indigenous peoples as “ignorant savages.” Nevertheless, while doing so would be essential, it would still be an oversimplification.

Another key topic emerging from the interviews was that community members characterized their ancestors’ wisdom and practices as *other than STE(A)M*. Take, for instance, how the basket weaver pointed out that while I was talking about science as an isolated entity, for her (and her community) the sky, Earth, and water are holistically related to the people. Furthermore, they do not regard nature as an external and inert element “waiting to be understood.” Her words reveal the transdisciplinary nature of Indigenous worldviews as well as the inherent importance that relationships have within them. Building on Wilson’s (2008) work, Indigenous ontology and epistemology allow for multiple realities; the truth is not ‘out there to be found out;’ rather, reality is in the relationship that one has with the truth. This alternative conceptualization of reality entails diverse ways to be and act in the world as well as different manners of creating and making in it.

Again, this finding has significant implications for design. Activities that, implicitly or not, present Western science and engineering as the “only” or the “first” systematic ways to understand the world and design for it fail to recognize historically disparate access to power. Also, incorporating the history and the scientific, engineering, and technological achievements of Native communities is crucial, and challenging views that label them as inferior or more primitive (Bang et al., 2013; Vossoughi et al., 2016).

Intersection of Wellbeing and STE(A)M

Participants shared diverse views on potential connections between wellbeing and STE(A)M, but the opportunity to and necessity of bringing together the traditional and the STE(A)M worlds was prevalent. This complex process, as many scholars have pointed out, has historically placed Indigenous knowledges and wisdom as inferior or primitive, but a productive ‘bringing together’ should presume an equal positioning. Moreover, it would be useful to acknowledge them as different forms of knowledge with historically disparate access to power.

Many interviewees pointed out art as a common element in STE(A)M and their traditional worlds, with some participants emphasizing the essential role of creativity in both. For example, a teenager mentioned “thinking outside of the box” as a key skill for both technological developments

and Indigenous Making practices (e.g., making regalia, making baskets). Additionally, the importance of incorporating art-based activities in initiatives that aim to foster Indigenous wellbeing revolved around the importance of providing people the opportunity to express themselves. Furthermore, as one of the interviewees explained, talking about one's feelings can be challenging enough, so art activities can allow one to get "negative emotions out" without the need for verbalization. These views align with (Herring, 1997), who suggests that the creative arts provide essential avenues of emotional, religious, and artistic expression for Native American peoples.

Another crosscutting theme was the usefulness, social standing, and undeniable gatekeeping embedded in STE(A)M fields. Connections to environmental science were frequently made, as interviewees saw this field as potentially linked to the improvement of their roles as stewards of the Earth. Some interviewees also talked about problems linked to the endangered status of cultural staples such as abalone and seaweed. While one could interpret these issues from a mere "resource management" viewpoint, doing so would fail to capture the significance of relational worldviews. For example, the Kashia leader (P15) explicitly talked about food in relation to their connection to the Earth and their stewardship, which brings up a key difference between some Indigenous and Western perspectives regarding the role of humanity (Bang, Marin, & Medin, 2018). As noted by an Elder from Big Valley, in Western thought, nature is traditionally seen as an object that has to be dominated. Nevertheless, many Indigenous peoples see humanity playing a role within nature, as nurturers and providers (Bang et al., 2018; Cajete, 1994; Elk, 2016). Also linked to the power and politics imbued in STE(A)M fields, participants acknowledged the undeniable rising role of digital technologies in daily life, and also as a requirement to access the job market. Thus, they are aware of the need to interweave STE(A)M into their cultures "to advance" but also "to maintain cultural resilience."

Having already discussed many of the opportunities brought up from working at the intersection of Indigenous wellbeing and STE(A)M fields, I now turn to two salient concerns mentioned by some of the participants. First, given the inseparability of wellbeing and spirituality, some interviewees expressed potential conflicts between science and their spiritual beliefs. Specifically, they expressed concern about their creation stories (and other relevant cultural stories) being contested by STEM curricula. This issue touches on a distinct and complex tension inherent to this type of project that requires understanding the worldviews of other communities – not exclusively Native American ones. While this work did not focus on offering a resolution to this particular type of tension, it is something that should not be neglected by designers working with communities in which traditional (or religious) stories play an important role – especially when those communities see their culture on the brink of extinction.

Second, some community members mentioned another problematic issue linked to STE(A)M education: conveying that STE(A)M fields are the (only) path to success (where success is conceived of as the accumulation of personal wealth). Reflecting on the connection between STE(A)M fields and "money making," one Elder emphatically shared that there is "more to life than a good job," and expressed concern about the tendency of STE(A)M fields to over-emphasize "mechanics" and neglect philosophies. In his view, it is the engagement with philosophies that has the power to open up the world to the youth. Therefore, particularly for this community, the idea of a career in STE(A)M fields as a path to wealth accumulation was not well-regarded, especially amongst Elders.

Amongst the many implications for design, two are particularly important. The first is that an Indigenous Making Learning Ecology centered in wellbeing should support onto-epistemic heterogeneity (Bang & Medin, 2010; Barajas-López & Bang, 2018a; Rosebery, Ogonowski, DiSchino, & Warren, 2010) – that is, acknowledging and engaging with diverse ways of being, acting, and making in the world without degrading any of them. Importantly, non-Indigenous novice designers with traditional STEM backgrounds need to accept and potentially embrace the fact that different communities have different worldviews. Particularly relevant to Indigenous communities is to honor

the strong connection between wellbeing, culture, and spirituality. Therefore, STEM initiatives should be very carefully conceptualized not to diminish or neglect Indigenous worldviews.

The second implication for design (and research) also relates to the discourse and values emerging from the project. The interview data show that economic prosperity and job market competitiveness (often normalized ways of justifying the need for STEM education in many other contexts³⁶), while important, might fail to capture the totality or essence of some Indigenous worldviews. This issue presents a particularly thorny tension because funding for research projects ordinarily comes from federal agencies that are focused on maintaining national competitiveness, fostering economic growth, and developing a scientific and engineering workforce. While the makerspace project itself had no funding, for a period of time the two U.S. graduate students were partially funded by a National Science Foundation (NSF) Research Traineeship grant.³⁷ The NSF, a U.S. federal agency, maintains that “no single factor is more important to the intellectual and economic progress of society, and to the enhanced well-being of its citizens, than the continuous acquisition of new knowledge” (NSF, n.d.-c). It claims to support science and engineering education at all levels “to help ensure that there will always be plenty of skilled people available to work in new and emerging scientific, engineering and technological fields” (NSF, n.d.-c). These excerpts suggest (similarly to the findings in this chapter) that the NSF’s notions around wellbeing and STEM education are at odds with the community’s perspectives. However, it would be overly simplistic to conclude that no transformative work is possible with funding from such agencies, or other private funders often connected to corporations. It is also worth noting that, as a result of research, activism, public pressure, and advocacy, in the last years several funding agencies in the U.S. have, at last, incorporated into their agendas and review criteria issues of diversity, equity, and inclusion. Particularly relevant to this work is the focus area of the NSF’s Equity Action Plan that acknowledges Native American peoples. The NSF aims to “remove barriers to enhanced participation by Indigenous and Native American communities” (NSF, n.d.-a), and although the existence of such a plan is definitely a step forward, this kind of discourse suggests a particular conceptualization of equity. Equity as “providing access” to non-dominant communities into dominant systems rather than challenging the systems themselves. Even though there was space in this work to question the very definitions of and justifications for STEM by the funding agency, the tension persists: what are the boundaries of that space, and how can we make sure it is systematically expanded?

Conclusions

In this chapter, I started by reviewing the research questions that guided the data analysis. I then presented the findings drawn from 21 interviews with 23 Native American peoples and one non-Native person who were affiliated with the PPN. I organized the findings around three main topics: *wellbeing, STE(A)M, and issues at their intersections*.

Most participants used notions such as balance, spirituality, and wholeness to describe wellbeing. Additionally, cultural connection and identity as well as healing from historical trauma were

³⁶ See, for example, the U.S. Department of Commerce’s report on “Good Jobs Now and for the Future.” (n.d.)

³⁷ The NSF is an independent federal agency created in the post-war context in 1950 to promote the progress of science and maintain the U.S. scientific leadership and global competitiveness (NSF, n.d.-a). Specifically, the NSF Research Traineeship (NRT) program addresses workforce development and is “dedicated to effective training of STEM graduate students in high priority interdisciplinary or convergent research areas” (NSF). This U.S.-based program’s funds are exclusively for U.S. graduate students. Therefore, neither PPN community members nor international students, like myself, can be supported using these funds.

sub-themes mentioned as ways to motivate and promote wellbeing. Perceptions of STE(A)M included links to ancestral wisdom and practices and emphasizing similarities and differences with normative STEM fields. Some interviewed people reflected on potential advantages of bridging the traditional and STE(A)M worlds together—without neglecting to mention some possible constraints. In general, STE(A)M education was perceived as a current necessity both to improve tribal stewardship of the Earth (from an environmental sciences approach), and as a path for youth to prepare for their futures. In the discussion section, I provided a summary of the findings and also shared some challenges I encountered in documenting and understanding perspectives rooted in worldviews distinct from my own. These challenges might be shared by other non-Indigenous and/or novice designers working with Indigenous communities. I propose that, by both entangling and juxtaposing the topics of Indigenous wellbeing and STE(A)M, we can both honor connections to valuable ancestral wisdom and practices, and acknowledge the ways in which these two worlds are distinct and irreducible.

Chapter 6

Introduction

The previous empirical chapters have drawn on an extensive data corpus to characterize the three-year trajectory of the makerspace project and to better understand the PPN's perspectives on wellness and STE(A)M. This chapter takes a different approach. Inspired mainly by Barajas-López & Bang's (2018a) definition of *Indigenous Making and Sharing*, and by Bang & Vossoughi's (2016) notions of *invisibility and critical reflexivity*, I propose the comparison of two analytical exercises to explore how filtering out a non-dominant community's perspectives may occur. Concretely, I take as my point of departure for this chapter a telling case (Mitchell, 1984), an interview with two culture keepers in which they talked about a key making practice for Pomo peoples: *basket making*. (See Appendix 6A for two examples of the products of this practice.) I examine the narrative presented by one of the interviewees using two separate coding systems. Each system has been adapted from one of two overarching frameworks that organically became part of the conceptualization of the makerspace throughout time. The first coding system was derived from the *Make your Makerspace* framework, which was developed by the UCB team in 2018 when initially thinking about the issues that should be considered when designing a *culturally sensitive STEM makerspace*. The second system has been borrowed from Begay's *Holistic Ecological Perspective* (2020) and Wilson's (2008) notion of relationality and it conveys the outlook through which I conceptualized the *Indigenous Making Learning Ecology Centered in Wellbeing* in 2020. These frameworks were not initially created as interview coding instruments, so I adapted them for this purpose, as is further explained below.

Research Question

The research question guiding this chapter is the following: *In what concrete ways could Indigenous worldviews be filtered by a non-Indigenous researcher's onto-epistemic optics?*

Methods

This chapter is centered on a telling case (Mitchell, 1984): an interview with two culture keepers. The origins of telling cases can be traced to the fields of anthropology and ethnography. Their potential lies in that, unlike representative cases—which aim to exemplify general patterns and tendencies across a data set—telling cases illustrate particular circumstances, which “make previously obscure theoretical relationships suddenly apparent” (Mitchell, 1984, p. 239). Using a telling case as the basis for the two analytical exercises presented in this chapter, I seek to illustrate how different lenses, as partial proxies for particular worldviews, can “filter the intelligibility of the practices of historically non-dominant communities through normative onto-epistemologies” (Bang & Vossoughi, 2016, p. 181).

The interviewees were two culture keepers: an Elder and her adult daughter. The two women from the Redwood Valley Rancheria describe themselves as basket makers and medicine makers. Close to the end of the interview, a second adult daughter joined the conversation. This encounter was graciously coordinated by the PPN's educational director, and before this encounter, I had not

interacted with any of the interviewees. The interview, lasting 94 minutes, occurred at the place where the daughter makes her baskets, and was both audio and video recorded with the participants' authorization. I have transcribed the entire audio interview, and this chapter focuses only on a four-minute excerpt. The identification of the four-minute excerpt used in this chapter followed a pre-coding phase (Saldaña, 2021) to find "relevant text" (Auerbach & Silverstein, 2003). That is, I carefully read throughout the transcript to identify text that would portray cultural making practices. Having selected the relevant text, I engaged in holistic coding (Saldaña, 2021) using the coding systems described below.

Analytical Perspectives

The act of coding requires that you wear your researcher's analytical lens. But how you perceive and interpret what is happening in the data depends on what type of filter covers that lens (Saldaña, 2013, p. 7)

This chapter draws on Charmaz's (2010) idea that coding is the critical link between data collections and their explanation of meaning, and uses Saldaña's (2021) analogy between the process of coding and the process of using a camera³⁸ to present an analysis of the same interview excerpt using two distinct coding systems (filters) derived from two separate frameworks employed at different times in the co-design process. Focusing on a short excerpt from a much longer interview, the aim of comparing and contrasting the findings arrived at through each of the two systems is to offer a concrete example of the potential role of the researcher in either illuminating or making opaque the community's worldviews, and subsequently facilitating or obstructing their expression in a co-design process.

The two coding systems I selected are derived from two overarching frameworks that organically became part of the conceptualization of the makerspace project and guided its design, with a roughly 1.5-year lapse between them (Figure 6.1). Neither was specifically developed with the express purpose of analyzing interviews and, importantly, each analysis, informed by one of the two frameworks, was conducted independently to best capture the underlying onto-epistemic differences between them. In fact, I adapted the first coding system from the *Make your Makerspace* framework. This framework was developed by the UCB team in 2018 in the context of this project for the purpose of facilitating the co-design of a STEM makerspace. I suggest that this lens serves as a partial proxy for my perspective on the design of a culturally sensitive STEM makerspace, as a novice non-Indigenous researcher. In other words, this lens allows for making visible some dimensions of cultural practices. At the same time, it has important limitations.

³⁸ "Researchers' eyes are like lenses. The way they perceive social life can be influenced and affected by the investigator's own significant demographics [...] Lenses might also consist of the particular research methodology or disciplinary approach employed for a study [...] Cameras also have filters covering their lenses that let certain wavelengths in and keep others out. The filters that cover a researcher's lens might consist of a set of personal values, attitudes, and beliefs about the world [...] Filters also consist of particular theoretical perspectives within a discipline." (Saldaña, 2021, p. 11)

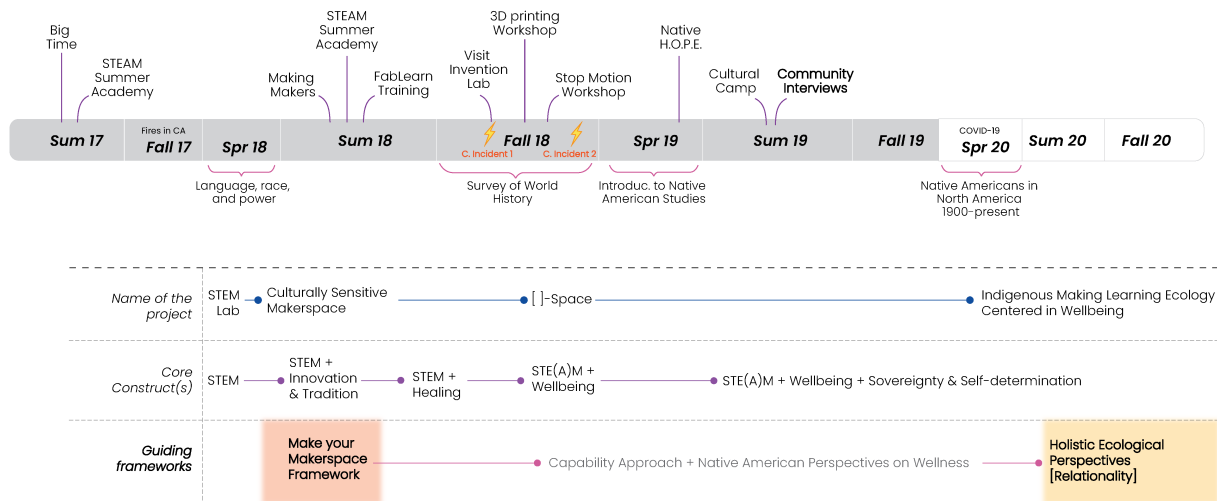


Figure 6.1. Timeline of the co-design process along with the corresponding guiding frameworks

I locate the second coding system, relationality (Wilson, 2008) within Begay’s “holistic ecological perspective” (2020), presented at the Indigenous Co-Innovation at the Nexus of Food, Energy, and Water Systems (CoInFEWS)³⁹ collaborative workshop that took place virtually on June 15th-19th of 2020. This perspective was presented as a way of sharing and explaining to a broad audience of Native and non-Native peoples the Diné worldview (Figure 6.2). In the following sections I provide an overview of the two frameworks, and offer a description of the coding systems I derived from them.

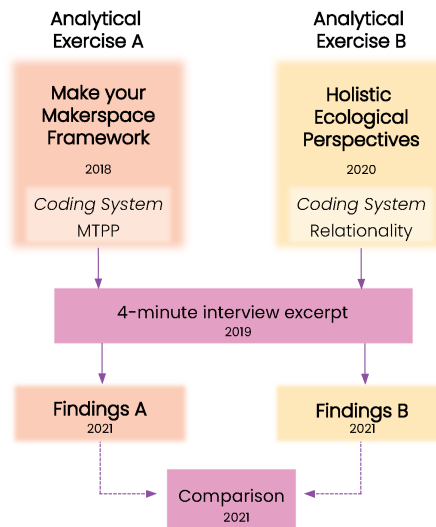


Figure 6.2. Strategy based in the comparison of two analytical exercises

³⁹ The CoInFEWS workshop was organized by UC Berkeley, the University of Arizona, the University of South Florida, and Diné College to determine how higher education institutions can collaborate with Indigenous communities on innovations at the nexus of food, energy, and water systems. It was originally to take place at Diné College, on the Navajo Nation’s reservation. However, because of COVID-19, it transitioned to a virtual format.

Make your Makerspace / 2018

The *Make your Makerspace* framework was created by the UCB team (i.e., the senior researcher and the three graduate students, including myself) in the first half of 2018. We developed it for the purpose of facilitating a) the UCB team’s conversations about the conceptualization of the makerspace, and b) the co-design process with the tribe. We attempted to capture in one place the many issues that should be considered during the co-design process of this type of space.

Its development took place during the spring of 2018 after the team had already interacted with the PPN, but before the personal shifts described in Chapter 4 took place. As described in Chapter 3, after the tribe talked to the UCB team about the STEM lab they were developing, there were many conversations that reframed this initiative. For example, the UCB graduate students’ knowledge in makerspaces and innovation—as well as our interest in culture—allowed for the STEM lab to be jointly re-thought as a culturally sensitive makerspace. Once the makerspace became one of the gravitational centers of the PPN-UCB partnership, the UCB team started to consider how we could adequately address cultural issues. This goal enabled specific conversations with the educational director, who, for example, brought up the complexity of designing and weaving Pomo baskets, the basket weavers’ admirable capacity to “plan all in their heads” and to “get a perfect triangle when [...] going around the basket” [Phone Call Notes, R1, May.10.2018]. Through continuous dialogue, we defined the long-term orientation of the makerspace project: designing a space where tradition and innovation could harmoniously intermingle.

In preparation for the first community workshop, *Making Makers*, in June 2018 (see Chapter 3), the UCB team held various meetings and an internal mock workshop—*Weaving Traditional and New Technologies*. During the workshop, the Berkeley team members explored how weaving as a *traditional* method could be combined with *new* materials (e.g., waste from recycling bins, LEDs, batteries, etc.) (Figure 6.3).

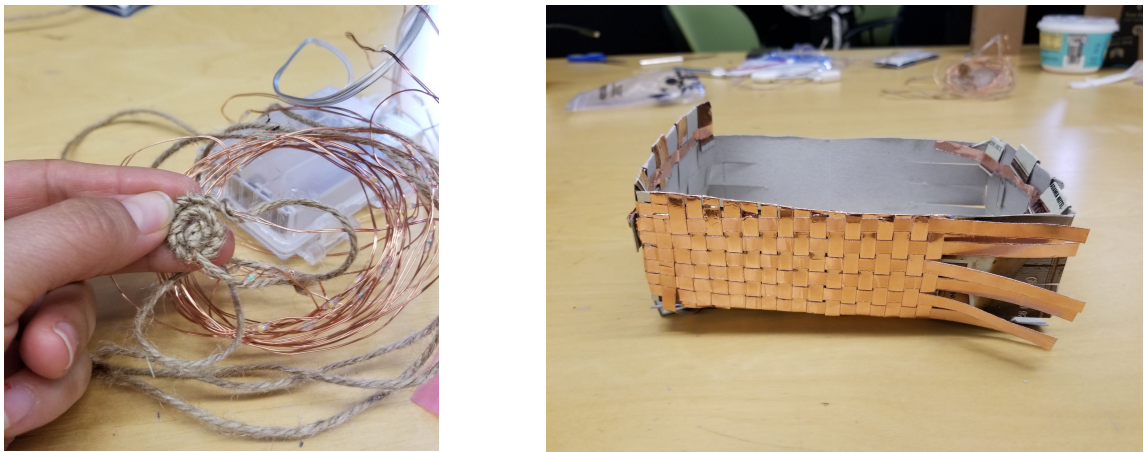


Figure 6.3. *Weaving Traditional and New Technologies* internal mock workshop held by the UCB team

The discussions that took place during these internal UCB team events were very generative and revolved around examining together with the community areas in which traditional making could be augmented with contemporary making through particular *products* (e.g., musical instruments, dance regalia such as flicker headbands or skirts, tools for fishing/diving, tools for basket weaving), *materials* (e.g., willow, sage, acorns, abalone shells), or *methods* (e.g., weaving, beading) [Email M10, UCB team, May.09.2018].

These ideas were eventually used to create the *Make your Makerspace* framework (Figure 6.4),

which attempted to facilitate the design of the makerspace by capturing the many issues that should be considered during the co-design process (e.g., *Who will be the target audience? What machines, kits, and software should be available in the space? What kinds of projects should take place?*) Additionally, it provided a space to define the goals along with some question prompts to clarify (or complexify) the definition of these goals (again, see Figure 6.4). Discussion around the framework captured meta-questions that team members were still thinking about, such as:

- What is making?
- Who is a maker?
- What is the relevance of STEM education for the PPN?
- What would a successful makerspace look like from the PPN's perspective?

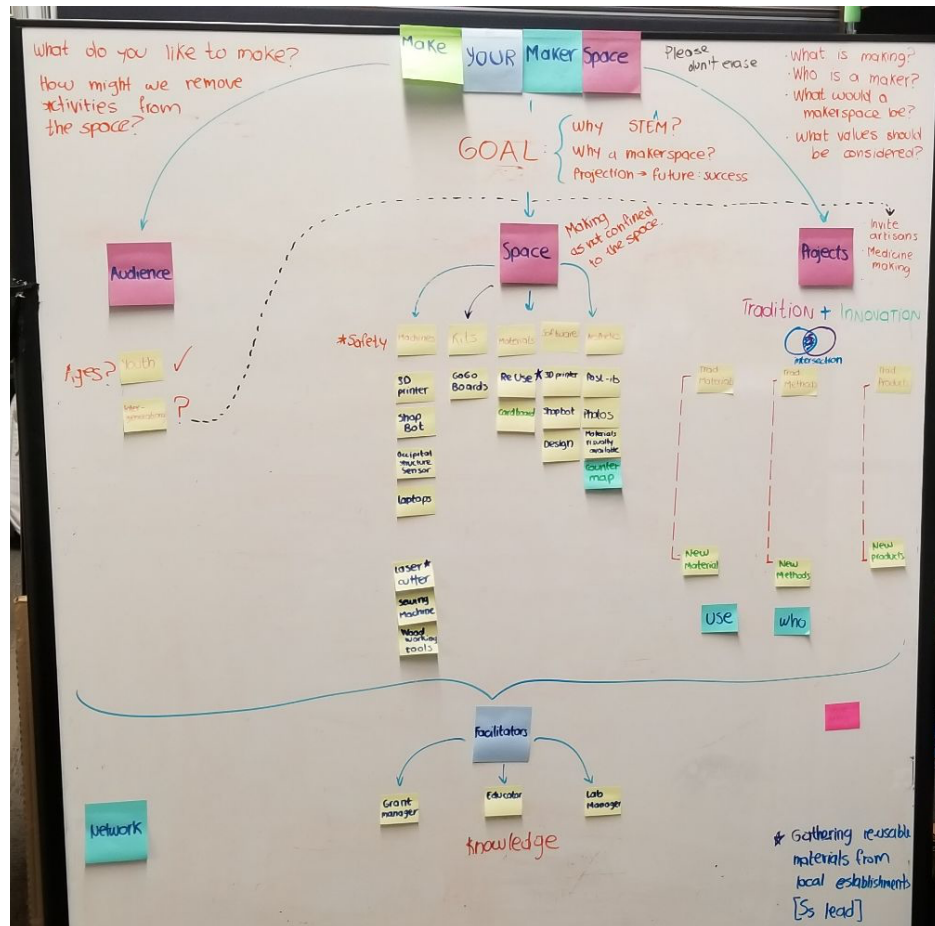


Figure 6.4. Brainstorming and discussions on the *Make your Makerspace* framework

MTPP Coding System

The core of the UCB team's conversations revolved around the projects piece of the equation. We initially considered three categories (materials, methods, and products) along a spectrum between tradition and innovation as guides to support our goal of adequately incorporating the much-desired cultural aspect into the makerspace project. In the final version of the framework, we decided that it would be helpful to think about four elements along the same tradition/innovation spectrum: materials, techniques, processes, and products. These four elements come together to form the MTPP

coding system, and are conceptualized as follows:

- **Materials** - Traditional and new materials that should be available in the makerspace (e.g., willow, motors)
- **Techniques** - Traditional and innovative techniques that could be used in the makerspace to transform the materials (e.g., weaving, carving, 3D printing)
- **Processes** - Actions, beyond the ones linked to a particular technique, that are part of the transformation of materials (e.g., harvesting, going to the hardware store)
- **Products** - Traditional and new objects or artifacts that resulted from a specific activity (e.g., baskets, key chains)

I chose this portion of the *Make your Makerspace* framework (i.e., the MTPP lens) as the first coding system for the analysis because these categories capture the way I thought we could adequately incorporate culture⁴⁰ into the makerspace project. In other words, the MTPP lens serves as a partial proxy for my worldview in 2018.

Holistic Ecological Perspective / 2020

This second framework depicts the outlook through which I started to conceptualize the *Indigenous Making Learning Ecology Centered on Wellbeing* in Fall 2020. By the end of the spring of 2020, after having experienced the shifts described in Chapter 4, I realized that the foundational human-centeredness of many of the theoretical frameworks that inspired my work rendered them inadequate for projects that aim to cater to Indigenous worldviews. While looking for alternative perspectives, I attended a virtual collaborative workshop, CoInFEWS, where Navajo scholar David Begay explained the Diné Indigenous worldview using what he called a holistic ecological perspective (2020). He shared that,

Implicit in Indigenous thinking is the perception that all things are naturally interconnected, meaning that everything works as a whole and undivided. Furthermore, it is systemic, organic, and ecological. Within this undivided ecological wholeness, everything is considered living, and with this understanding, those things considered not alive by western standards, are alive through their interconnectivity with those living. Begay (2020) (Refer to Chapter 1 for more details.)

Relationality Coding System

These ideas are not easy to process for a person who has been raised in a Western tradition. Revisiting the work of Shawn Wilson, an Indigenous scholar whose work I had read when I first joined the PPN-USB partnership, helped me to contextualize Begay's holistic ecological perspective. Wilson's (2008) frame for explaining notions of Indigenous relational ontology and epistemology to a wide audience of Indigenous and non-Indigenous peoples was particularly helpful to me. He uses relationality as the core construct to describe both notions. Relationality implies that nothing can be without being in a relationship—without its context. To further explain these ideas, he details four dimensions:

- **Relations to People:** This refers to the importance of all forms of interpersonal relationships,

⁴⁰ I want to call attention to the use of the word 'culture' in this sentence. "Incorporating culture into" suggests that I saw culture as something somehow tangible, something that could almost be easily 'imported' or 'transported.'

new and old. Wilson (2008) refers to standard introductory protocols among Indigenous peoples to exemplify how the discovery of common relationships (be they with other people, with places, with events, or with ideas) aids in the establishment of new, strong relationships.

- **Relations to Land/Environment:** Given that Indigenous peoples' ways of being, ways of knowing, and ways of doing (K. Martin & Mirraboopa, 2003) have been shaped by the environment, a sacred relationship has emerged between them and the Land. This relationship is the foundation of their spirituality, identity, sense of belonging, and stewardship (Wilson, 2008).
- **Relations to the Cosmos:** The author defines spirituality as one's internal sense of connection to the cosmos, (interpreted widely as a higher being, humanity, the environment, etc.). Although the manifestation of this relationship is especially evident during ceremony, it is also ever-present in everyday life. For instance, Lionel Kinunwa, a Minnecunju Elder, explained that a visible ceremony (e.g., a sweat lodge) is only "the period at the end of a long sentence" (Wilson, 2008 p. 89). Significant time and work are devoted to building up relationships with the cosmos that allow visible ceremony to happen (Wilson, 2008).
- **Relations to Ideas:** An Indigenous perspective sees knowledge and knowing as cultural and contextual. When pairing a relational epistemology with a relational ontology, one can conclude that hierarchies in belief systems, social structures, and thoughts are inadmissible. Egalitarianism and inclusiveness are fundamental for any epistemological conceptions, which implies that judgment toward others' ideas is inconceivable. Each person should develop his or her own relationship with ideas and form his or her own conclusions (Wilson, 2008).

I decided to use Wilson's (2008) relationality—situated within Begay's (2020) holistic ecological perspective—as the second lens for the analysis because, in 2022 these notions better aligned with my evolving understanding of culture. Thus, I was actively using these ideas to re-think what it meant to design a culturally sensitive makerspace. Once more, I decided to use this lens because it represents a partial approximation of my shifting worldview in 2022.

While these two frameworks were created for very different purposes, none of which was the analysis of interviews, the connecting thread between them is that the two represent the ways in which I was conceptualizing the makerspace project at two points in time, in ways that resonated with a new and growing body of literature that centered Indigenous perspectives.

Having described the two coding systems I will use in this chapter, I next introduce the interview excerpt to be analyzed, and then share how the application of each analytical frames yielded different findings by highlighting different elements, and how and to what extent those elements connect to Indigenous worldviews.

The interview

The following four-minute excerpt is taken from the aforementioned 94-minute interview that took place between myself and two Native American culture keepers. The session started with introductions, and then I asked them about their thoughts on wellbeing and potential connections between Indigenous wellbeing and culture. Then the conversation organically moved into the realm of cultural practices. Roughly 40 minutes into our conversation, I asked them about what Making meant to them, framing this by saying that, "from what I have been learning, Making from a Native perspective is not exactly the same thing as making from a Western perspective." The transcript below depicts the daughter's answer (I have slightly edited the original transcript to improve readability without significantly altering meaning):

- 40:41 No, it makes me cry. [For] a full-size cradle basket, I harvest a ton of willow, and I would say only maybe 5-12% of those willow sticks are even suitable for a large cradle basket. But before I even get to that stage, we have to tend the plants, which means gifting to the plants which alkalize the soil, and I talk to the plants and give them gifts. And these are plants that have been from great aunties [...]
- 41:26 If a baby is born in Lake County, I'll go to my plants [there] and get the material, you know? [...] our friend just had a baby, and I got all the sticks, and everyone in my family wove on the cradle... [cries]
- 42:02 [It] takes about 120 to 150 sticks to make a full-size cradle, and it takes between 8 to 12 minutes to strip each stick to prepare it. That's just the time to prepare the materials, then it has to dry, and then it takes about a week to weave it. I mean, you have to bend the <ocum?>, and you can't harvest the rim until the baby comes. And there's a whole thing about the rim, has to sing a song for the baby. It's all kinds of stuff, right? [cries] And that's before you even put it together. I mean you put it all, and then you have to smudge it, you have people bless it, and then you put the baby in it. And that's just one thing. The first gift, and that's making [...]
- 42:55 Clappers are like that. You have to know the tree. You have to know that the tree can sustain that. The feathers, you have a relationship with the bird. You even need to know where they live. So, everything that gets made, it's more the intention that goes into every single thing. It's not easy. If I were to make a cradle the old way, not only would I have to do all those sticks, but I have to make the cord to tie the basket together. That's a lot of work.
- 43:37 The making is the most important part, [not] the finished product. [...]
- 43:59 We even have stories, you know, myths about spirit ways into things that you create [...] because of that, all those things that we make, that represent your wealth. The wealth in your family. So, making stuff is a big deal.

Findings

MTPP Coding System

Analyzing the interview excerpt using the MTPP coding system emphasizes the elements and processes required to make a baby cradle basket. In essence, this framework facilitates a 'clinical' identification of materials (e.g., willow sticks, feathers), techniques (e.g., weaving), processes (i.e., the 'recipe' for producing an artifact), and products (e.g., baby cradle basket, clappers). (See Figures 6.5 and 6.6.)

● Materials ● Technique ● Process ● Product

No, it makes me cry. [For] a full-size cradle basket. I **harvest** a ton of **willow**, and I would say only maybe 5 to 12% of those **willow sticks** are even suitable for a large **cradle basket**. But before I even get to that stage, we have to **tend the plants**, which means **gifting to the plants** which alkalize the soil, and I **talk to the plants** and **give them gifts**. And these are plants that have been from great aunties [...] If a baby is born in Lake County, I'll go to my plants [there] and **get the material**, you know? [...] our friend just had a baby, and I got all the **sticks**, and everyone in my family **wove on the cradle**... [It] takes about **120 to 150 sticks** to make a **full-size cradle**, and it takes between **8 to 12 minutes to strip each stick** to prepare it. That's just the time to **prepare the materials**, then **it has to dry**, and then it takes about **a week to weave it**. I mean, you have to **bend the <ocrum?>**, and you can't harvest the rim until the baby comes. And there's a whole thing about the rim, has to **sing a song for the baby**. It's all kinds of stuff, right? And that's before you even put it together. I mean you put it all, and then you have to **smudge it**, you have people **bless it**, and then you put the baby in it. And that's just one thing. The first gift, and that's making [...] **Clappers** are like that. You have to know the tree. You have to know that the tree can sustain that. The **feathers**, you have a relationship with the bird. You even need to know where they live. So, everything that gets made, it's more the intention that goes into every single thing. It's not easy. If I were to make a **cradle** the old way, not only would I have to do all those **sticks**, but I have to make the **cord** to tie the basket together. That's a lot of work. The making is the most important part, [not] the finished product. We even have stories, you know, myths about spirit ways into things that you create... because of that, all those things that we make, that represent your wealth. The wealth in your family. So, making stuff is a big deal.

Figure 6.5. Color coding of the excerpt using the MTPP coding system.

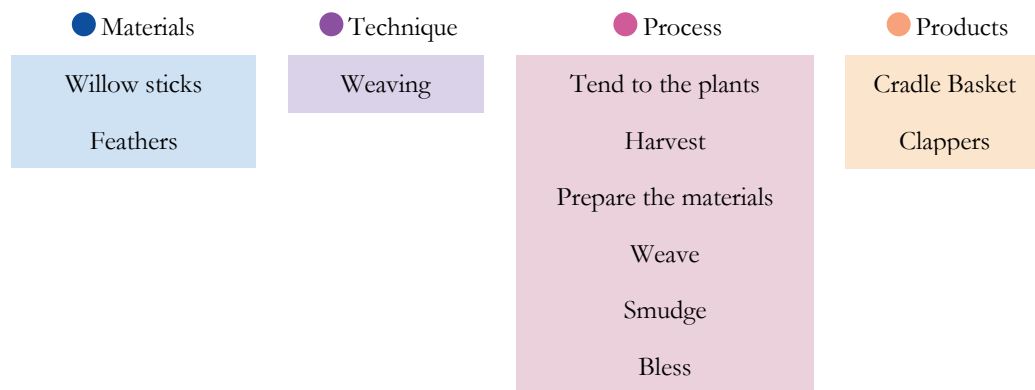


Figure 6.6. Findings from the MTPP coding system.

This identification would be useful in informing design decisions about the space. Even so, this lens does not capture most of the second half of the excerpt. The basketmaker's points about "knowing the bird," or "singing a song for the baby," for example, simply do not register under this point of view since they do not touch upon specific materials, techniques, or processes. This framework relegates them to a secondary role, extraneous and unrelated to the 'actual' making of the baskets. Therefore, although this lens captured relevant materials and cultural practices that were likely not found in traditional makerspaces, the *Make your Makerspace* framework associated with this STEM-centered conceptualization of the project had no place for fundamental aspects of the community's worldviews. Realizing that and how this "filtering out" was occurring led me to the thought experiment of coding the same interview data using a relationality lens based on the four above-mentioned categories: *People, Land/Environment, Cosmos, and Ideas*.

Relationality Coding System

The analysis of the basketmaker's narrative through a relational lens (Figures 6.7 and 6.8) forces an emphasis on fundamentally different aspects of the interview than the previous analysis. First, the passage about "harvesting willow," which the previous framework categorized as concerning materials and processes, is now attributed to considerations of the Land and Environment; the "materials" are not segregated from the Land or from the environment. Thus, people's stories and voices and their relationships were not included in the first framework and analysis, including great aunts and other family members, but are now clearly included as central to the analysis (See "Relations to people" category.) Other previously uncaptured processes, such as the blessing of materials, singing a song for the baby, and getting to know trees, are now emphasized and convey the community's cosmological views. Finally, previously uncoded ideas about the value of making ("it's more the intention that goes into every single thing") and definitions of wealth ("those things we make represent your wealth") emerge as salient under a relational lens.

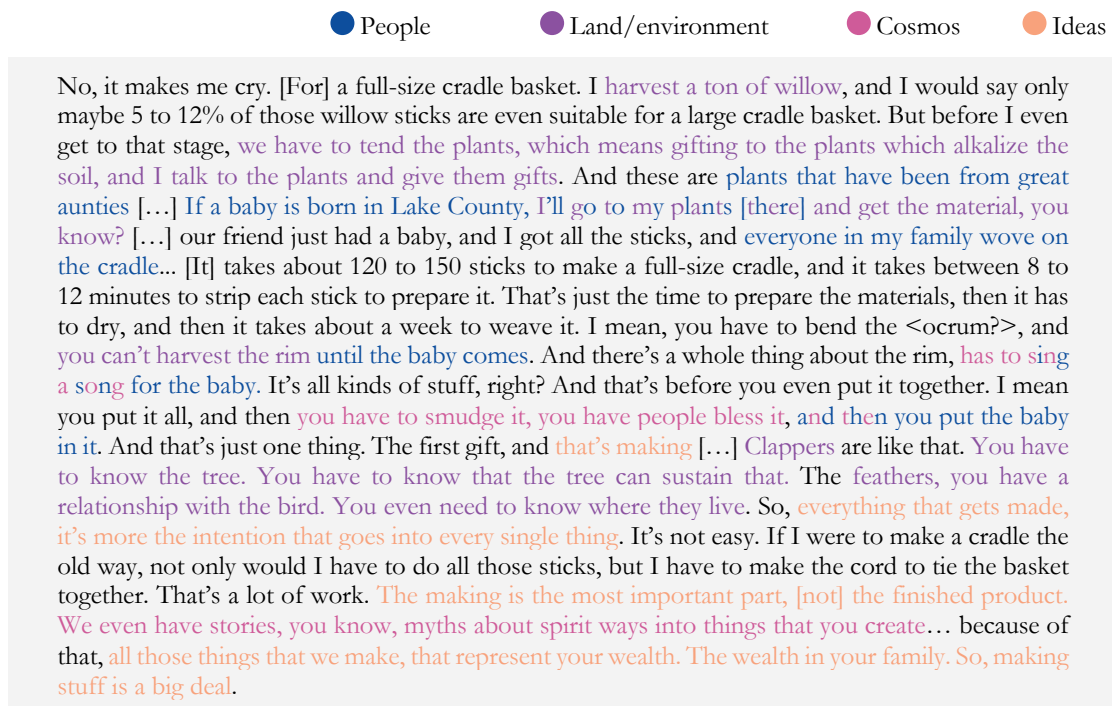


Figure 6.7. Color coding of the excerpt using the relationality coding system

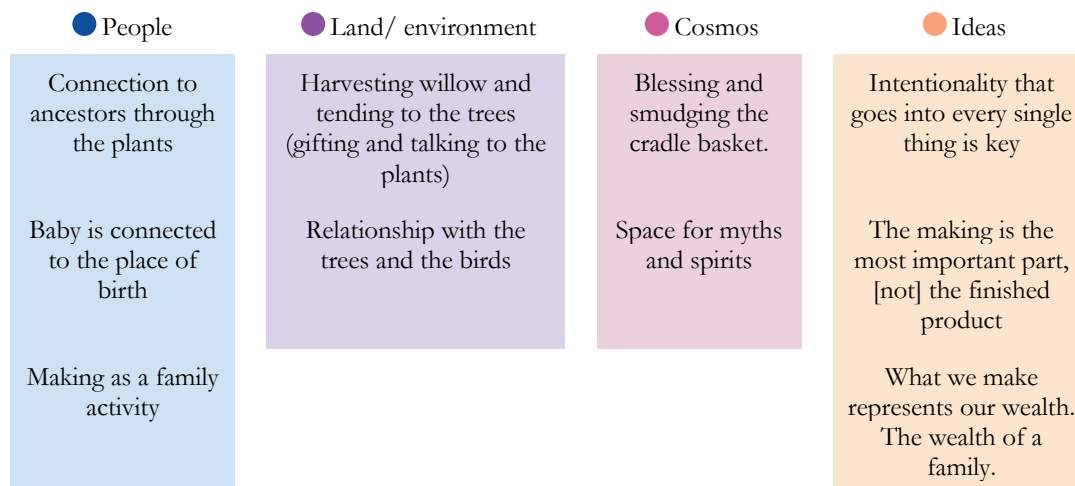


Figure 6.8. Findings from the relationality coding system

Given the stark differences in how these two frameworks filter or amplify different elements of this interview shown above, I next discuss their differences by contrasting the findings. I then consider how each would differentially inform the co-design of a makerspace.

Discussion

Analyzing the brief example above highlighted how differently Indigenous cultures can be understood when using two coding systems, one saturated with a Western STEM worldview and developed to design a culturally sensitive makerspace centered in tradition and innovation, and the other nurtured by core Indigenous philosophy. As I mentioned before, I derived these coding systems from two analytical perspectives that were originally developed for purposes other than coding interviews. In a way, I have ‘reappropriated’ and ‘misused’ these perspectives for coding purposes. However, this comparative analytical strategy emphasizes the different understandings of culture that I had and also derived from using each coding system to conceptualize and inform the makerspace co-design project. Even if culture is a focus for a novice non-Indigenous designer, pre-existing frameworks that reflect worldviews other than that of the focal culture can obscure vital cultural elements and practices that might be made salient by a framework specifically designed to center an Indigenous worldview. In this case, when designing a makerspace, a well-meaning non-Indigenous designer might be tempted to account for culture by including traditional materials, processes, techniques, and artifacts in the space. However, the holistic ecological perspective and its concomitant relationality reveal that culture encompasses much more than that, as illustrated in how the culture keeper talked about the relationship with her ancestors through her plant relatives, the importance of place and spirituality. Thus, while both coding systems and their root analytical perspectives aim to center culture in their own ways and for their own purposes, each system construes culture differently in ways that have significant implications, in this case, for the makerspace design and people’s experiences within it. (I discuss this further below.)

As its name implies, the *Make your Makerspace* framework inherently focuses on making as it occurs in a makerspace: the audience, materials, techniques, processes, and products that exist within a given physical space (e.g., who should be available and for whom; what materials and machines should be bought and how should they be displayed, etc. to facilitate particular making practices). It

is, in essence, a very pragmatic space-design framework. The holistic ecological perspective is a framework with which one can attempt to understand a worldview different from one's own—insofar as any true understanding is possible here. This perspective inherently operates at a much broader scale. Though not formulated to analyze maker practices specifically, using it in this way *demand*s attending to a broader view of culture and cultural practices and reveals the numerous and vital ways in which those practices transcend the boundaries of any one physical space.

It is worth noting that the *Make your Makerspace* framework is not inherently flawed and may, in fact, be helpful in informing the physical design of an Indigenous-serving makerspace. But, as a tool to inform the broader design process and understand the ways such a space can contribute to the community's wellbeing, it is too narrow—too focused on a predetermined physical space to capture the interconnected ways through which this community's maker practices can support their wellbeing. The holistic ecological perspectives framework, also, has limitations: it was not created to inform the design of a space. Here Bang's and Barajas-López (Bang et al., 2013; Barajas-López & Bang, 2018a) work is particularly instructive.

Potential Filtering Effects

The differences between the two coding systems become especially clear when examining what they highlight or obscure/obfuscate. MTPP helps define a list of cultural artifacts along with the materials, techniques, and processes needed to produce them. Its pragmatism and clinical nature portray a utilitarian, almost disembodied view of making, suggesting that providing certain materials and including traditional techniques would automatically make the space more attuned to the community's culture and needs. In contrast, the relationality coding system enables a more comprehensive understanding of the cultural practices and philosophies relevant to the community, as well as what kinds of familial and communal responsibilities are valued, and how the community embodies nature-human relations (Bang & Medin, 2010). At the same time, its philosophical nature does not yield immediately actionable design strategies.

Part of the *Make your Makerspace* framework's focus is on identifying culturally-appropriate processes of material transformation to inspire maker projects. It does not, however, examine the taken-for-granted assumptions about the goals of transforming those materials as well as the community's deeper, culturally-constructed relationships with both those materials and their transformations. Both frameworks clarify that, for this culture keeper, making a basket begins with tending the plants, long before actually putting the materials together. However, the relationality embedded in the holistic ecological perspective allows us to appreciate the special relationship that the basketmaker has with the Land, with people, with the cosmos, and with ideas. For example, she talks about gifting to the plants, suggesting that she sees them as equals—as relatives (Bang & Medin, 2010). The connection goes further, as her trees link her to her basketmaker ancestors. She also facilitates deep connections to the Land for the baby recipient by harvesting trees from the baby's place of birth. Her stewardship and harvesting practices reflect a special relationship with her plant and animal relatives via tending them, feeding them, talking to them, and basing her harvesting practices not on *what she needs* to create the basket but on *how much each of them (e.g., a tree) can sustain*. She portrays basket making as a practice that can be collaborative: a whole family weaving, singing, and blessing the basket before it is given to the newborn baby. Finally, she emphasizes the importance of intentionality—the time and care of making are what give the final artifact its value—which in turn, redefines wealth: “all the things that we make represent our wealth.” All these relationships with the Land, people, and time would have been lost if only the MTPP framework had been used.

Implications for Design

This comparison of frameworks facilitated by the coding systems derived from them also generates contrasting implications for design at levels ranging from organization, budgeting, and architecture to the discourses validating the existence of such a makerspace. The ‘hidden curriculum’ of makerspaces might be expressed through the space allocation for different materials and technologies, and through decisions around which technologies occupy the lab’s prime real estate. The space architecture, the decoration, and the people/artifacts represented in posters might also communicate values and status. Other elements, even if not physically present in the space, can communicate priorities to the community; for instance, if the budget allocation disproportionately privileges digital fabrication machines or only offers certain types of technical training programs and implicitly relegates more culturally-grounded practices to a lower tier, community members can easily read a larger message about priorities in these choices.

In a traditional makerspace, materials typically include wood, acrylic, fusible polymers, electronics, and cardboard. The materials used to make Pomo baskets (e.g., willow sticks, feathers) are rarely present in a prototypical makerspace or even considered as “maker” materials. But the divergence goes beyond the materials themselves and includes how materials are sourced. In a traditional Western makerspace, maker materials are brought to the space regularly, ready for use, and their sourcing is rarely a point of attention. A high diversity of materials is considered a best practice: consumables are bought in large quantities, made abundantly available and visible to students, and then discarded even after superficial use. But what would a space informed by holistic ecological perspectives look like? Based on the interview above, we can imagine that a makerspace reflecting those perspectives on the Land/Environment might instead include a plot for plant-relatives, include tools and ritual items for use in their care, or perhaps supply funding to support travel to regional plots where those animal and plant relatives live.

Apart from materials, the techniques used to work with the materials are also different. In a Western school makerspace, for example, techniques are generally dictated by typical prototyping technologies: physical computing, laser cutters, and CNC (computer numerical control) machines. The basketmaker brings a technique (weaving) that must be done by hand,⁴¹ and that could be done collaboratively. It could be that spaces informed by the practice of these techniques would include not only material tools but also spatial and social arrangements (e.g., open floor-space; collective, multi-generational events) to support their enactment.

The holistic ecological perspectives discussed in this chapter have more profound implications for design: Even the ways by which machines in a makerspace transform and shape materials might be guided by values at odds with some Native worldviews. For example, CNC machines and laser cutters were designed for industrial applications, and therefore prioritize precision, speed, and reproducibility, all of which are highly valued in traditional engineering. These machines define a “hylomorphic” relationship between humans and materials; that is, that operate on the assumption that form can be “imposed by an agent with a particular design in mind, while matter, thus rendered passive and inert, became that which was imposed upon” (Ingold, 2010, p.92). While precision, speed, and reproducibility can be helpful and needed in some contexts, they are counterproductive in others. For a space guided by the proximate, meaningful relationships with the materials valued by relational worldviews, a hylomorphic relationship would be inappropriate. As noted by one of the Elders, the contribution of making practices such as basket making or beading to Indigenous wellbeing partially

⁴¹ Even if weaving could in theory be automated, such automation is not desirable. As discussed in the interview excerpt, it is the process—more than the final product—that is the central value of Making in these communities.

hinges on the meditative and reflective state induced in executing those practices by hand. Taking a holistic ecological perspective warns against introducing technologies that could change Indigenous making practice in culturally counter-productive or damaging ways.

One possible path for navigating between diverse worldviews could be to design spaces in which transitions between types of material relations are not only possible but incentivized. Participants could be made aware of hylomorphic and non-hylomorphic perspectives (the maker “joins forces” with “active materials” and works with them “in anticipation of what might emerge,” Ingold (2013)) and encouraged to transition between them in close communication with other voices in their own and other communities (e.g., the voices of Elders, artisans, and/or engineers). For example, it could be that design software could enhance a design planning process that is then subsequently executed by hand, or that machines are modified or used in subversive ways (e.g., as slowly as possible) to prioritize the community’s worldviews. The very investigation into these hybrid techniques could become a piece of critical or installation art (Devendorf & Ryokai, 2015).

This work suggests that the engagement with any type of Making (e.g., digital fabrication, Indigenous Making) *should also entail reflecting on the history, values, affordances, and constraints associated with it*. STE(A)M initiatives that aim to foster Indigenous resurgence and wellbeing *should support onto-epistemic heterogeneity* (Bang & Medin, 2010; Barajas-López & Bang, 2018a; Rosebery et al., 2010). In other words, the design of an Indigenous Making Learning Ecology Centered on Wellbeing should pay special attention to the facilitation of participants’ ability to navigate between multiple ontologies, epistemologies, and Making practices depending on their intentions and necessities.

Limitations

The intent of this chapter was to open a conversation about how to employ more robust notions of culture as part of the conceptualizations and design principles necessary for co-design work. However, more work is needed to advance the tentative methodological claims derived from the two analytical exercises above. In particular, the different natures of the two coding systems prevent a direct comparison between them. Future work could better adapt the frameworks, in a methodological sense, to offer more robust insights into interviews specifically. Frameworks such as these would be useful not only for extracting insight from interviews such as the one discussed here, but also as a window into cross-cultural communication more generally.

One of the challenges of cross-cultural communication is finding common ground. As Wilson (2008) says, “The reader must be able to comprehend the writer’s beliefs in order to see what the writer sees. When this is not happening, miscommunication is inevitable” (p. 7). I believe that it would be presumptuous of me to assume that I fully comprehend Begay’s and Wilson’s beliefs. Therefore, and despite all my efforts, I have at best been able to develop a partial relationship with the holistic ecological perspective, Indigenous ontologies and epistemologies, and relationality. Thus, I am possibly missing core ideas of Indigenous worldviews and their implications, and this possibility only further underscores the importance of working side-by-side with culture keepers.

Conclusions

The contrast in the findings afforded by the two coding systems underscores how many of the issues brought up in previous chapters (e.g., reflecting on one’s identity and positionality, understanding the interactional space, engaging in constant self-reflection, developing a shared vision of core constructs) can be consequential to the interpretation and filtering of non-dominant community’s ideas. In this chapter, cradle basket making provided an example of an Indigenous Making practice which embeds

their worldviews (as described in Chapter 5).

With this example, I do not mean to imply that the first framework (*Make your Makerspace*) would not be valuable for the project. It could result in a space that would be much more responsive to the community's needs than other makerspace designs. However, the analysis in this chapter shows that if the coding system fails to capture the community's worldviews, many of the perspectives that could inform the space's design get "filtered out." One can consider changing materials or processes in a makerspace to accommodate willow or weaving, but there is no ontological or epistemological "space" for blessings, dialogue with plants, or personal relationship with animals. These elements, derived from the very core of the communities' worldview, are more than simple procedures to 'get things made.' Rather, they signal the value and the permanence of communities' culture, history, and traditions. They signify the valuing of Elders and previous generations and speak to the tribe's history of oppression and hardship.

Unaware of these dimensions, a well-meaning designer might well consider these issues as not pertinent to the makerspace design. From some perspectives (e.g., many Western ones), blessed willow will not behave differently than non-blessed willow when cut or bent. However, as Chapter 5 shows, Indigenous wellbeing is interwoven with spirituality, and an analytical segregation of this kind therefore reduces Indigenous perspectives to a normalized Western ideal. The makerspace becomes a microcosm of past and present struggles and historical events, and it becomes impossible to ignore the colonizing perspective and effect of bringing in techniques, machines, or processes from the outside that touch upon one of the few surviving cultural practices of the community: Making things. As the basketmaker explained ***"The making is the most important part, [not] the finished product."***

Chapter 7

The general question that has guided both the design and the research in this dissertation is: *What are the best practices when non-Indigenous novice designers work with Indigenous communities to co-design a transformative learning ecology anchored in Indigenous Making and wellbeing?* In this case study, I have examined the co-design process of an *Indigenous Making Learning Ecology Centered in Wellbeing* under the context of the 2017-2019 PPN-UCB partnership. I believe that engaging in an extensive analysis of a case in which certain theoretical design sensibilities (emancipatory and political agendas, Freire, 1970; Gutiérrez et al., 2020) encounter real-world challenges sheds light on how to improve design and research efforts in which non-Indigenous novice researchers work with Indigenous communities. In many ways this case study includes an autoethnography, as I carefully document the onto-epistemic and axiological shifts that made this work possible.

Community Participation and Representation in Co-design Processes

Initially oriented by the literature available in both fields of engineering design and learning sciences, it became clear that community participation throughout the design process was a key factor to consider. Community participation is essential to cultivating transformative agency (Bang et al., 2016; Gutiérrez et al., 2020), disrupting normative power dynamics between researchers and “the researched,” and preventing the filtering of the “intelligibility of practices of historically nondominant communities through normative epistemologies” (Bang & Vossoughi, 2016). Chapter 3 both described the events that characterized the design process and presented a quantitative analysis of the representation of different stakeholders. This provided a better understanding of the interactional space, which revealed subtle, but very consequential, representation trends and divisions of labor. For example, UCB designers interacted constantly with PPN staff members, but this interaction took place mainly with *non-Indigenous* PPN staff. The consequences of these trends emphasize the differences between general community participation, which is focused on the core design team interacting with the broader community, and participation that is focused on the key members of the community. The latter type of participation requires tribal members to be an integral part of the design/research team and to engage in everyday design activities so transformative learning can take place from the start of the process.

Shifts in Researcher’s Perspectives

The interactional space described in Chapter 3, along with the UCB team composition (non-Indigenous designers), made me wonder whether merely having representatives from the Indigenous community would be enough to accurately represent their worldviews in the design. Thus, in Chapter 4, I explored the idea of the evolving designs being ultimately impacted by a non-Indigenous researcher (myself) acting as a “filter” on the incorporation of the community’s worldviews. Through

a self-reflective process which examined data from three years, I identified two main shifts that profoundly changed the way I conceptualized the makerspace project. First, I went from thinking that STEM was universally positive for any community, to considering that STEM, as a “Western construct” connected to histories of oppression, could not possibly contribute to the wellbeing of Indigenous peoples. This led to a more nuanced and complex view that contemplated diverse forms of adoption and rejection of STEM along with different levels of criticality, informed by constant listening to the community’s complex needs and designs.

The second shift was from an at-best limited understanding of the centrality of Indigenous sovereignty and self-determination to identifying these principles as key elements of Indigenous wellbeing, and thus as critical to the design of the project. In Chapter 4, I suggest that while community participation remains essential in a co-design process, it might not suffice for the resulting design to reflect the community’s worldview. Due to the specific divisions of labor between the UCB team and the PPN staff, and within the PPN staff and the larger community, the community’s way of being, seeing, and Making in the world might not have been fully considered, resulting in a design that failed to capture their worldview.

Community Perspectives on Wellbeing and STE(A)M

As a result of considering the design process, community representation (Chapter 3), and the evolving nature of the researcher as a potential filter of Indigenous perspectives (Chapter 4), the need for a shared vision of core constructs and commitments for the makerspace project became apparent. Thus, in Chapter 5, I aimed to understand the community’s view of wellbeing and STE(A)M fields. According to community members, wellbeing is not only about balance, spirituality, and wholeness, but also about fostering cultural connections and identity, and healing from historical trauma. Community members’ perceptions of STE(A)M were multifaceted. There were references to ancestral wisdom and practices, with some participants also pointing out that STE(A)M is only a new term to describe some aspects of those ancient practices. In addition to being linked to wellbeing, STE(A)M education was regarded as an important path to prepare youth for their futures, while simultaneously improving tribal stewardship of the Earth. I conclude that, by both entangling and juxtaposing the topics of Indigenous wellbeing and STE(A)M, we can both honor connections to valuable ancestral wisdom and practices, and acknowledge the ways in which these two worlds are distinct and irreducible.

Applying Two Coding Systems to a Pomo Making Practice

Finally, Chapter 6 presents an excerpted case, the basket-making practice of a culture keeper, as a microcosm of the issues addressed in the previous empirical chapters. Analysis of this case served two functions: First, it emphasizes the relational nature of Indigenous Making practices, which elevate people, the land and environment, the cosmos, and ideas; secondly, in a broader sense, it speaks to

the concerns that prompted this dissertation, namely the potential role of the researcher in either filtering out or facilitating participants' perspectives.

Embracing History as Possibility

As this work draws to a close, the reader might ask: in the end, what are the best practices when non-Indigenous novice designers work with Indigenous communities to co-design a transformative learning space? This journey has suggested several avenues, such as self-reflection and learning; providing appropriate infrastructures for interactions between researchers and community members; paying attention to issues of division of labor and access to culture keepers; monitoring the amount and nature of the interactions between stakeholders; and openness to non-dominant worldviews. However, another important consideration is that the solutions are local: we need new and imaginative ecologies and possibilities for both researchers and Native communities around culture, wellbeing, and STE(A)M. These imaginative possibilities should go beyond the canonical formulations of makerspaces or mere integration of new materials and processes. But they also must fulfill the multifaceted and nuanced desires and needs of Native communities—recognizing and attending to the variance within and across communities—, which often find themselves trying to maintain a complex equilibrium between survival and resurgence that hinges on, among other things, healing from historical trauma, cultural preservation, and diverse generational needs.

This is not easy territory to tread on, given the historical record of trauma and oppression, and the history of problematic relationships between universities and the scientific establishment and non-dominant communities. Despite these challenges, I choose to believe that with empathy, generosity, rigor, care and intense listening, we can do better. I choose to *corazonar*⁴² (Guerrero, 2011) through Paulo Freire's words: *"I do not accept history as determinism. I embrace history as possibility."*

Reflexiones Finales

Esta disertación comenzó con el ímpetu de mejorar la educación en una comunidad. Evolucionó hacia una profunda autorreflexión y transformación. Al final, me di cuenta de que mis deseos de ayudar a la comunidad y de cambiarme a mí misma no eran suficientes. Lo que se necesitaba era algo más, más allá del discurso académico, el rigor científico y las páginas registradas en los archivos de UC Berkeley. La lección fundamental de esta disertación es que los procesos de cambio individuales y comunitarios simplemente no caben en las dimensiones analíticas a las que nos limitamos. Llegar a esta conclusión me tomó años, y no se reveló en las continuas revisiones de la literatura, ni en el análisis exhaustivo de mis interacciones con la comunidad.

Llegó uno de mis últimos días en la comunidad, cuando la persona que hace canastas me contaba como los palitos de sauce se convertirían en una cuna que algún día cargaría a una niña. Mientras lágrimas acariciaban su cara dijo,

It's important for the next generation not to be afraid of where they come from.

⁴² Patricio Guerrero enfatiza la "necesidad de empezar a corazonar como respuesta espiritual y política insurgente, puesto que el corazonar reintegra la dimensión de totalidad de nuestra humanidad al mostrar que somos la conjunción entre afectividad e inteligencia." (p. 29)

[...] Nobody has the greatest backstory; you can tell that from superheroes. Anybody can be whatever they decide to be, but know where you come from, know where your heart belongs, and be proud even if it's a bad story, be proud because it can change.

Nuestras miradas se encontraron y en sus lágrimas profundas, sentí su dolor y el dolor de mil generaciones antes que ella. En esos segundos, sentí la presencia de nuestras abuelas y abuelos, y tantas vidas reprimidas. Sentí que los Andes Ecuatoriales tocaron la costa de California, e imaginé una cuna milenaria cuidando cariñosamente de una nueva vida. En este instante, comprendí el verdadero sentido de ese makerspace que nunca llegó a existir. Sin embargo, en esa falta de concreción surgió algo más: una nueva relación con el mundo, una nueva forma de verlo, vivirlo, y sentirlo.

Y así, quizás el resultado más hermoso de este viaje de ocho años no fue haber encontrado las respuestas, sino haber encontrado formas más hermosas de hacer preguntas; no fue haber cumplido un sueño, sino haber descubierto nuevos sueños para soñar.

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Appendices

Appendix 1A. Pinoleville Pomo Nation Departments and Their Initiatives⁴³

Department	Initiatives
Health and human services	Wellness Center Healing Native Youth Minds Project Youth Substance Use Disorder Prevention Program
Education services	Native American Youth & Adult Partnership Youth Reinvestment Program Tutoring Center
Highway Safety Program	Educational outreach to reduce the number of serious injuries and fatalities on roadways
Environmental	Environmental education and outreach Protection and restoration of the watersheds in the area, Renewable energy and green technologies
Native American Early Head Start Program	Early Head Start Head Start
Vocational Rehabilitation	Pinoleville Pomo Nation Vocational Rehabilitation Program (PPNVRP)
Housing	Low-income housing and housing assistance
Social Services	Pinoleville Child Care Plan Low Income Home Energy Assistance
Self-governance	

⁴³ As listed on the Pinoleville Pomo Nation's web page (PPN, n.d.)

Appendix 2A. Semi-structured Interview Protocol for Adults and Elders

1. Would you mind telling me a little bit about yourself? Whatever you want to share with me is fine.
 - a. How old are you?
 - b. What tribe are you from?
 - c. Where do you live?
2. Is there anything that you would like to ask me?
3. If you could have one superpower, what would it be? Why?
4. If you could learn to do anything in the world, what would you like it to be?
5. What is your favorite activity in the world? What is something you could do for a long time without getting bored or distracted?
6. If you had the chance to start working on a personal project (anything), what would you like it to be?

Wellbeing & Culture

7. Now I want to ask you to tell me the first thing that comes to mind when I say two words. Ready? The first word is: 'culture.' The second word is 'well-being..
8. What role does culture play in your life?
 - a. Would you like it to play a bigger or smaller role in your life?
9. How important do you think culture should be for the new generations?
 - a. If important, how should new generations learn about it?
 - b. What should they learn?
10. Do you think there is any connection between culture and wellbeing? If so, what do you think about that connection?
11. Do you ever think about your culture and STEM (science, engineering, math) as connected somehow?
12. Do you think that learning about the history of your people might contribute to community members' wellbeing or ill-being? How?
13. What would you say are the most common obstacles people from the community face in trying to achieve wellbeing?
14. If you had a space where you could do whatever makes you feel content, happy and peaceful,
 - a. What would you do there?
 - b. What things would you have there?
 - c. Who would be there with you? Who should not be there with you?
 - d. When would you go there?

STE(A)M - Art – making – crafts

15. What are the first things that come to mind when you hear these words?
 - a. Science
 - b. Engineering
 - c. Mathematics
 - d. Art
16. From what I have heard, a lot of people around the world are talking about science, engineering, tech, and math. Why do you think that is? Do you agree with them?
17. What do you think someone needs to study or practice in any of those fields?
18. Could you picture yourself as a STEM person? Why yes/why not? What would you be doing now?
19. Would you have liked to have pursued a STEM field?
20. Would you like your kids (or kids in your community) to do so?

21. What do you think could be the role of STEM people in your community, if any?
22. What are, if any, some cultural conflicts with STEM?
23. What do you think are the disadvantages or advantages of studying in a STEM field?
24. Are you personally interested in arts and crafts? For example, basketry, beading, jewelry, paintings, etc.
25. Do you know/enjoy making crafts?
 - a. What do you like to make?
 - b. How did you get into making that?
 - c. Have you taught it to someone?
 - d. Would you be willing to share your expertise with other people?
 - e. What do you feel when you are making [whatever they mentioned]?
26. Do you see a connection between what you made and STEM?
27. Is there something from these fields, or other fields, that you would like to learn about?

School experience

28. To start, I would like to ask you to tell me the first thing that comes to mind when I say a word. It doesn't matter what it is, but it is important to say the very first thing that comes to mind. It can be a thing, a person, a feeling, or whatever. Ready? The word is: 'school.'
29. What do you remember from your days in school? What good or bad memories stand out for you?
30. Can you think of anyone (at school) who helped you to overcome obstacles and lifted you up when you needed it?
31. Can you think of a person or an incident that made things worse for you in school, made you feel bad (inadequate, out of place)?
32. Do you think your experiences in school were like the ones of the non-Native children?
 - a. How were they different?
 - b. How were they similar?
33. Do you think that Native worldviews are respected in school?
 - a. What if you consider the way some of the elders from your tribe think about life?
 - b. Have you had any personal experiences with this issue?
34. Have you heard about the experiences Native children have in school these days?
 - a. How are they different from your own experiences?
 - b. How are they like your own experiences?
35. What do you think young people from your community expect to get out of going to school?
 - a. If aid is required: Imagine you are asking one of them 'why do you go to school?', what would you hear back?

Education

36. Now I want to ask you to tell me the first thing that comes to mind when I say a word. It doesn't matter what it is, but it is important to say the very first thing that comes to mind. It can be a thing, a person, a feeling, or whatever. Ready? The word is: 'education.'
37. What educational activities did you engage with outside of school?
38. If we choose a broad definition of education (going beyond schooling), what are your hopes for the education of the younger members of the community?
 - a. If aid is needed, prompt the participant to think about the future and to dream about how they would like to see the kids she/he/they know.
39. What would you say are the most common obstacles young people from the community face in their educational journey?
40. Who should be making decisions about the education (broad definition) of the people in your community?

41. Let's imagine two future scenarios for a young person:
- If everything in his/her/their education goes as it is supposed to (the sky's the limit), what does his/her/their life look like?
 - What concerns do you have that might prevent he/she/they from achieving these goals?

Success

42. Now I want to ask you to tell me the first thing that comes to mind when I say a word. It doesn't matter what it is, but it is important to say the very first thing that comes to mind. It can be a thing, a person, a feeling, or whatever. Ready? The word is: 'success.'
43. Can you think of a person who you consider to be successful? It could be someone you know or don't know personally. You don't need to tell me the name of the person if you don't want to. What do you think the life of this person looks like?
44. Who defines what success is?
45. What do you think are the key things children and people in general should learn in order to be successful in life?

Other

46. Could you recommend names of people who we could also interview?
47. We are planning to have some workshops with the community so you guys can define the []-space. What would be a good way to get community members to engage with the project?
48. We are looking for community members who care about education and wellbeing and who would like to be part of an 'advisory committee' for the learning environment we are designing. Who do you think we should try to recruit?
49. We are also looking to hire an intern. Ideally this young leader from the community should feel passionate about education and be interested in working with us in the design of the space. Do you know someone we should reach out to?

Appendix 2B. Recruitment Flyer for Semi-structured Interviews



**PPN & UC BERKELEY ARE SEEKING PARTICIPANTS
FOR A RESEARCH STUDY**

ARE YOU NATIVE AMERICAN AND 10+ YEARS OLD?

This opportunity is for you!

We are recruiting children, teenagers, adults, and elders. We want to hear your voice!

Goal of the Study

We want to hear your thoughts and experiences around education and Science, Technology, Engineering, Art, and Math (STEAM). This information will help us to design a space (we are calling it []-Space for now) where Native People from Mendocino County will have the opportunity to gather, share, design, create, explore, invent, and learn. Participants will be selected based on a broad representation from all tribal communities from the county.

To participate you must

- Respond before June 24, 2019 **AND**
- Be 10 years old or older **AND**
- Be Native American **OR**
- Have a close relationship with Native American peoples **OR**
- Work for a Native American Tribe

Participating involves

- Being interviewed for up to 1.5 hours
- Being audio, video-recorded
- \$30 gift certificate + \$20 additional for elders over 60 years old!

First come, first served! (30 spots)

If you want to find out more about this study, please contact Jacqueline Sanchez or Elena Durán at:



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Appendix 3A. Normalization Table Used to Calculate Team and Sub-team Representation

Period		UCB.nNA. fr	UCB.nNA.g	UCB.nNA.u	PPN.c	PPN.nNA. sf	PPN.NA	UCB.t	PPN.t
2017	Summer	1	3	0	4	2	1	4	7
	Fall	1	3	0	4	3	1	4	8
2018	Spring	2	3	3	4	1	0	8	5
	Summer	2	3	3	4	1	0	8	5
	Fall	2	3	3	4	2	0	8	6
2019	Spring	2	2	0	4	2	0	4	6
	Summer	2	2	0	4	2	0	4	6
	Fall	2	2	0	4	2	0	4	6

Appendix 3B. Half-sheets Used to Gather Community Member Input

Problem? - What problems in the community should we address?	Age?	Gender?	PPN? YES NO
One issue per card!			
Success? - What does a better world look like, when this issue is addressed? What does change look like long term? What would you look for to see change?			
Berkeley UNIVERSITY OF CALIFORNIA			
Solution? - What different ways can we address these problems? What if the idea was a product? An organization? An experience? A service? A policy?			
Berkeley UNIVERSITY OF CALIFORNIA Issue # _____			

Appendix 3C. Making Makers Workshop Flyer

**The Academic Success and College Prep Resource Center &
UC Berkeley's CARES team invite you to
celebrate the end of the academic year!**

The flyer features a vibrant design with a large purple circle in the center. Inside this circle is a photograph of two young women working on a project in a workshop. Surrounding the central circle are several colorful, geometric shapes in shades of blue, green, yellow, and red. The text is arranged in a clear, organized manner, with the event title and date at the top, followed by the program details in a list format. At the bottom right, there are two circular logos: one for Pomo Youth College and another for The Sovereign Nation of Pomo. The overall aesthetic is modern and engaging, suitable for a community event.

**June 8, 2018
12 pm - 4 pm**

Making Makers

A STEAMing activity for academic success youth and their families

Program:

- 12:00 - 1:00 pm Reception with snacks and light refreshments
- 1:00 - 1:15 pm Opening prayer and welcome by Pinoleville Pomo Nation Representatives
- 1:15 - 1:30 pm Welcome and opening remarks: John Winters, Education Director of the Academic Success and College Prep Resource Center
- 1:30 - 1:45 pm Learning through making: Alice Agogino, Professor of Mechanical Engineering, UC Berkeley
- 1:45 - 3:00 pm STEM Lab/Makerspace grand opening and workshop with UC Berkeley students - Weaving old and new technologies of making
- 3:00 - 4:00 pm Student awards

Pomo Youth College
STUDENT SUCCESS
LIVES HERE
Career Success Project

The Sovereign Nation of Pomo
Ya-Mo-Bida

[illegible]

Appendix 3E. Examples from the Wellness Booth at the 2019 Cultural Camp



Appendix 4A. Syntax and Key for Reading Data References

Syntax

[<Type of data source, sub-code>, <Code of researcher(s) who created the artifact>; <date or page>]

Key

Type of Data Source	
Code	Description
FN	Field note
MN	Meeting note
MP	Meeting picture
CN	Course note
PP	Prospectus presentation
EM	Email

Course Note	
Sub-Code	Description
ED	Language, Race, and Power
IAS45	Survey of World History
NA20B	Introduction to Native American Studies II: Cultural Practice, Art, and Identity
NA72	Native Americans in North America 1900-Present

Examples

- [FN, R1, Sep.21.2018]: Field note created by researcher 1 on September 21, 2018.
- [FN, R1, R2, & R3, Oct.20.2017]: Field note created by researchers 1, 2, and 3 on October 20, 2017.
- [CN, ED, R1, p. 9]: Course note from *Language, Race, and Power* created by researcher 1. Content found on page 9.
- [MP, R1, May.29.2018]: Meeting picture taken by researcher 1 on May 29, 2018.

Appendix 5A. Semi-structured Interviews: Participant information

Int. code	Length [min]	Age Group	Gender	Tribe		Location of tribe
A	43.35	Elder	F	Pomo	Pomo tribe (Yorkville and Yokayo)	Mendocino County, CA
B	59.5	Elder	F	Pomo	Pinoleville Pomo Nation	Mendocino County, CA
C	94.48	Elder	F	Pomo	Redwood Valley Rancheria	Mendocino County, CA
C	94.48	Adult	F	Pomo	Redwood Valley Rancheria	Mendocino County, CA
C	94.48	Adult	F	Pomo	Redwood Valley Rancheria	Mendocino County, CA
D	70.65	Adult	F	Pomo	Pinoleville Pomo Nation	Mendocino County, CA
E	61.45	Adult	F	Pomo	Sherwood Valley Rancheria and Yokayo Rancheria	Mendocino County, CA
F	62.93	Adult	M	Pomo	Pinoleville Pomo Nation	Mendocino County, CA
G	1.92	Adult	F	Pomo	Pinoleville Pomo Nation	Mendocino County, CA
H	31.23	Adult	F	Pomo	Pinoleville Pomo Nation	Mendocino County, CA
I	64.27	Adult	F	No	Paiute Shoshone tribe	Inyo County, CA
J	15.38	Adult	F	No	Round Valley Indian Tribes	Mendocino County, CA
K	90.15	Elder	M	Pomo	Big Valley band of Pomo Indians	Lake County, CA
L	63.07	Adult	M	No	NA	Mendocino County, CA
M	51.78	Adult	M	Pomo	Kashia Band of Pomo Indians	Sonoma County, CA
N	66	Teen	M	Pomo	Coyote Valley Band of Pomo Indians	Mendocino County, CA
O	55.98	Teen	F	Pomo	Scotts Valley Rancheria	Lake County, CA
P	59.72	Teen	F	Pomo	Hopland Band of Pomo Indians	Mendocino County, CA
P	59.72	Teen	F	Pomo	Hopland Band of Pomo Indians	Mendocino County, CA
Q	56.77	Adult	M	Part Pomo	Round Valley Indian tribes	Mendocino County, CA
R	81.83	Adult	M	Pomo	Scotts Valley Band of Pomo Indians	Lake County, CA
S	38.08	Teen	M	Pomo	Coyote Valley	Mendocino County, CA
T	62.67	Adult	M	Pomo	Hopland Band of Pomo Indians	Mendocino County, CA
U	54.57	Teen	M	Nd	No tribal affiliation	Mendocino County, CA

Appendix 6A. Pomo Baskets

Description: Feathered truncate-cone coiled basket with a broken black band around the bottom. Feathers include western bluebird (blue), mallard (black), pileated woodpecker (red), and meadowlark (yellow). White, red, and blue glass beads and abalone shell pendants on a cotton string. Clamshell beads at the rim. Wefts are sedge with black dyed bracken fern broken band near the base; probable willow warps (n.d., n.d.-a).



Description: Basketry cradle (n.d, n.d.-a)

