Reimagining Place-Based Education for our Postdigital World

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Abstract

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In the three papers that form this dissertation, I inquire about the future of learning (Ross, 2023) through a *postdigital* stance (Jandrić, 2017) that I apply to place-based education (PBE) methods and practices (Sobel, 2005; Greenwood, 2008). I argue that a postdigital approach – one that presupposes technology is *part* of the world and not *separate* from it – should be applied to place-based education to support the goals of PBE which emphasize cultural awareness, meaning making and social responsibility (Sobel, 2005). This premise contradicts current PBE pedagogies which advocate for better, more environmentally supportive technologies (Greenwood, 2015) rather than examining extant digital practices that reflect authentic place engagement. I situate place-based learning within a postdigital stance by describing the complex spatial configurations of digital and analog geographies that young people regularly negotiate (Taylor, 2017). The three papers I present here serve as three different lenses of investigation into how young people learn about place through emergent digital geography practices. Each study takes on a different lens through a series of curriculum design experiments (Cobb et al., 2003) that together form the foundation of what I call *postdigital place-based education*. I focus on local and culturally relevant geographies of interest to young people as they learn across analog and digital spatial contexts. Through my findings, I argue that approaches to place-based education (and the future of learning more broadly) must include heterogeneous, multivocal (Bakhtin, 1975; Ladson-Billings, 1995) perspectives (Haraway, 1988) to support learning in the postdigital age. To demonstrate this concept, I present three papers that address various aspects of postdigital education applied to place-based learning. In each of the three papers, my overarching research questions are:

What could postdigital place-based learning look like? How might we design and analyze it? What do postdigital pedagogies tell us about the future of learning (Ross, 2023)?

To answer these questions, I investigate three lines of inquiry through three studies spread across three articles:

1) In the first paper, I propose a methodology for analyzing postdigital place interactions across multiple analog/digital contexts. In this paper I ask *how might we analyze learning across analog/digital spatial configurations?* I first present the argument that learners produce place through an analog/digital continuum that is constituted through sociotechnical interactions with the analog environment. I then present a framework called the *cartographic continuum* which I apply as a heuristic to a postdigital PBE curriculum that I collaboratively designed with youth involved in the study. Through the cartographic continuum, I demonstrate how the materiality of configurations across postdigital place-based contexts (Lave, 1999) contribute to and confront persistent visual spatial representations (Goodwin, 2018). I demonstrate how the cartographic continuum foregrounds traces across analog/digital boundaries, and through this I demonstrate the agentic, *autopoetic* (Varella & Maturana, 1974) or self-replicating and recursive relationships that young people use to produce postdigital place (Grushka, 2022; Vargas & Schaeffer, 2022).

2) In the second paper, I ask *what do young people learn about place when digital encounters are presented alongside analog ones? In other words, how might we design for postdigital place-based education and why?* In this curricular design experiment (Cobb et al., 2003), I include digital place encounters as part of an emergent theory of postdigital place-based education. To explore the possibilities and tensions of postdigital PBE, I take young learners on a series of place encounters to explore the local historic and controversial Duwamish River from multiple analog and digital perspectives. Through

comparison across different encounters, I observed young learners engaging in *interpretive distance*, a requirement of deep historical learning or understanding as theorized by Hans-Georg Gadamer (2013). Taking from a larger study of six place encounters spanning two quarters, I focus on video, image artifacts and written reflection data collected from 18 undergraduates over the first three place encounters of the curriculum. To explore the Duwamish River, I took the undergraduates in this study to walk its banks, visit the Duwamish cultural center and then walk the area again in virtual reality (VR) via Google Earth. By comparing multivocal situated perspectives (Bakhtin, 1929; Haraway, 1988), I was able to elicit what I call *claiming moments*, or unexpected realizations. Claiming moments indicated that learners had opened-up to an opportunity for deeper understanding of their role in time and place, or what Gadamer (2013) refers to as *historically effected consciousness* (HEC). I report on findings from this curricular design paper and argue for the necessity for the heterogeneity of many narratives; "i.e. the onto-epistemological assumption that the world is messy and that scholarship should thus engage with this messiness rather than try to smooth it out into generalisations and universals" (Macghilchrist, 2021) as theorized by postdigital scholars. Applied to place-based education, this means an emphasis on a multiplicity (Massey, 2005) of stories that span analog and digital place.

3) In the third and final paper, I conceptualize new analytical methods for evaluating learning through immersive and windowed (e.g., desktop and portable device-distributed) digital geographies. To do this, I trace the lines of learners across different configurations of digital geographies as they learn about their home, neighborhood and cultural place-based histories. I apply a *learning along lines* (Taylor, 2017) methodology to understand how learners engage with place learning in both VR and desktop Google Earth environments. I then trace lines through first-person perspectives using screen recordings of learners in Google Earth VR and on the desktop. By following learners as they "travel" through different configurations of Google Earth (on desktop and in VR), I attend to their rhythmic patterns of movement to learn how the digital environment assists or hinders their learning about time. Borrowing from cinema theory (Deleuze, 1998), I compare the material qualities of digital configurations of space and place,

specifically through Google Earth. I was especially interested in exploring the *Time-Image* through my data as in that text, Deleuze (1998) asserts that the liberation of the camera reveals time rather than space (1998). Through the analysis of lines of learning, I ask *how do different digital materialities of Google Earth support and/or hinder young people's temporal negotiations as they move through the digital environment?* I extract learners' lines of digital travel from the data through several methods, and compare across them. I then link lines to interactions that I code relevant to learners' temporal narratives, which I call *chronopaths* (cf., Bakhtin, 1981). By comparing chronopaths, I gained new insights into how learners learn along postdigital lines which I apply to suggestions for future directions in postdigital place-based learning.

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DEDICATION

For Sam, Claire and Isak – my three greatest teachers.

And Erle Malone, who lives in my heart always.

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OVERVIEW

Spatial technologies have been rapidly transforming the ways we collectively engage with place and time, but have largely been left out of place-based education (PBE) theory and practice. Meanwhile, Facebook (now Meta) has launched the VR (virtual reality)-based *Metaverse*, locative and GIS mapping technologies are embedded into every smartphone (Kilday, 2018), and Apple is leading the way to unleash wearable augmented reality AR devices upon the networked population (Perry, 2020). Through this transformation, PBE practices have responded somewhat to calls for critical place-based engagement (Sobel, 1999; Greenwood, 2003; 2015) in order to uproot PBE's historical focus on the "natural world." However, critical PBE continues to reinscribe nature-culture divisions that pit technology in opposition to place knowing, engagement, and identity despite efforts to the contrary (Greenwood, 2007). For example, in Greenwood's 2007 treatise on critical PBE, he addresses PBE uses of technology, while positioning it as an accessory to place, claiming that technology "...limits, devalues, and distorts local geographical experience" (Greenwood, 2008, p. 317). Regardless of the veracity of this statement, I question the validity of separating spatial technologies from geographic practice, engagement, and learning. It is here, at the intersection of technology and PBE, that I propose an investigation into theories, practices, and methods of place-based learning in the postdigital age.

The term *postdigital* refers to the sociomaterial realities of modern life where digital technology is no longer "'other' to a 'natural' human and social life" (Jandrić et al, 2018). A postdigital perspective of education rejects false dichotomies of "online" versus "offline" learning while acknowledging the importance of embodied interaction (Fawns, 2019). The erroneous notion that clear divisions exist between online and offline worlds overlook the sociomaterial realities of knowing and being in the world (Barad, 2007). Mundane uses of technology are pervasively integrated into the fabric of modern life to the degree that our infrastructural dependence renders usage invisible. For example, it is assumed that if I email my home address to you with the instructions that we meet on a particular day and time, I am assuming that you have 1) a computer; 2) an email account; 3) access to the Internet; and 4) a smartphone connected with 5) data, that is 6) location-aware. This one, mundane example of a common, everyday

transaction highlights the networked digital infrastructure that is simultaneously both treated as a privilege and task most can reasonably assume learners (or most anyone) can access (Eubanks, 2018). Likewise, learners are often assumed to be socially networked members of connected technical assemblages (Latour, 1987; Hayles, 2007), yet operate in education contexts that ignore this reality (Jandrić, 2017; Macgilchrist, 2021). Subsequently, the role of technology in educational research is often based on the "separation of an authentic inner 'humanness' from external and alien 'technology'" (Knox, 2019). As such, education technology-related research is featured in a supporting role, typically as an uncritical "enhancement" or learning intervention that supports accepted curricular content and outcomes (Knox, 2019).

I address this problematic paradigm from a postdigital stance by investigating new theories of spatial learning and engagement through everyday location-aware and environment-aware technologies. Locative technologies have presented unique opportunities to mobilize learning into local communities and contexts. Handheld devices (like smartphones) or head-up displays (HUDs like Google Glass or Microsoft's Hololens) layer visual and/or auditory meaning upon the analog environment. These technologies range in immersiveness and ubiquity as well as cost accordingly (Dear, 2022). The most common locative technologies are derived from smartphone use, and are designed to "remediate" the environment by layering meaning upon it (Sakr et al., 2016). AR has been used to increase engagement through tourism and museum visits (Yoon, et al, 2012; Haron et al., 2019), or by gamifying education through scavenger hunts (Fakhour et al., 2019) and environmental observation and simulation (Klopfler & Squire, 2004; Squire & Klopfler, 2007; Sharples, 2007). The most successful AR use of late has been *Pokemon Go* which has spawned a series of less competitive offshoots like Pikmin. Collectively, these technologies speak to broader questions about the rapidly expanding roles that emergent digital systems play in local place and community learning and interaction and what it all means for the future of education.

Locative technologies are not neutral (Franks, 2017) nor are they evenly distributed (Franks, 2017), and have been documented to reinscribe asymmetrical power structures that recreate social and

racial inequities (Layland et al, 2018; Eubanks, 2018). Despite these shortcomings, technologies of place offer valuable learning opportunities through historical layering (Sakr, Jewitt, & Price, 2016; Rogers Hall et al, 2020), mobile learning and mapping (Taylor, 2017; Mitchell & Elwood, 2013), and opportunities to virtually explore the world beyond one's own city (Parsons et al., 2019). Emergent technologies and subsequent interactions call for new theories of place that account for both digital and analog spaces and allow us to think about learning in new ways (Ross, 2023). In response, I theorize a postdigital version of PBE that leverages spatial technologies to configure space across the analog-digital continuum. I refer to this spatial construct as the cartographic continuum (CC), and formally investigate in paper #1. Thinking through the materiality of digital devices is a postdigital move that I employ to address the "contextual vacuum" (Macgilchrist, 2021) that pervades technology in education, which is why I begin my dissertation talking about it. Across my work, I have informally applied the CC as an analytical heuristic by which to consider the agency of the digital environment in PBE.

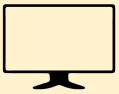
	Analog 	**Digital Analog** 	**Layered Digital** 	**Augmented Digital** 	**Mixed Digital** 	**Immersive Digital** 
Device	Analog	Window-Into Place *Computer*	Window-Informing Place *Mobile Device*	Window-Inscribing Place *Mobile Device*	Heads-up display (HUD)	Head-mounted display (HMD)
Place experienced via:	the "real" world	cartographic representations	location-aware assistance	rendered objects	immersive rendered objects	the immersive virtual world
Common Examples	written guides, static maps	interactive digital maps (Google Earth/Maps, etc.)	GPS navigation, Navigation apps (Google Maps, etc.)	AR apps (Pokemon Go, Starchart, etc.)	AR glasses (Google Glass, MS Hololens, etc.)	VR headset/application setup (Oculus, HTC Vive)

Figure 1: The six configurations of the cartographic continuum.

The CC operationalizes the material aspects of current technologies as learners use them to configure and reconfigure spaces into place, community and identity. To further theorize the CC, I draw upon theories of place (Cress, 2007), embodiment and mobility (Farman, 2017), and spatial media (Leszczynski, 2015). In paper #1, I propose the CC as a methods framework and delve more deeply into an analytic application of the CC to postdigital PBE. The CC emphasizes that the continuum does not differentiate between "virtual" and "real" space, and that as technologies evolve, so do the material elements of the CC. Conceptually, a continuum at once acknowledges the false dichotomies between "real" and "virtual" while simultaneously mediating and producing analog space. Originating from a term used by cartographers to "make progressive transitions between various levels of abstraction" (Hoarau & Christophe 2017), the CC is a construct of space that operates both internally and externally. Mapmakers theorize the cartographic continuum as a way to move between abstract and photorealistic renderings, and in doing so make choices about relevance while maintaining fidelity to place (Horeau & Christophe, 2017). This is a useful way to think about emergent digital geographies as Google Earth becomes increasingly photorealistic in its modeling of analog environments.

Applied to my research, the CC operates in the middle of Lefebvre's "triad of space" (Lefebvre, 1991, p. 33). It is what links perceived, conceived, and lived space into a mental construct that collectively represents and creates the relational experiences of a place. As a mental tool, the cartographic continuum represents how learners maintain a "continuity of activity over contexts" (Lave, 1988) both socially and culturally (Gutiérrez, 2008). As learners navigate along configurations of the continuum, multiple configurations dialogue with one another (Massey, 2005) and create social and material boundaries. It is through making sense and interacting with these analog/digital worlds that the cartographic continuum is produced and reproduced through the materials and digital devices that digital geographies are distributed. The CC simultaneously distinguishes between materials while depending upon a non-dualistic view of materials and interactions; the CC is method to design for the *pluriverse*, or the many worlds that have been ontologically disconnected (Escobar, 2018). As a construct, the CC aims to reconnect relationships and surface blurred boundaries. It challenges Western epistemic dominance by

presenting an ontological view that "the world is not something that is given to us, but something we engage in by moving, touching, breathing, eating" (Varela, 1991, p. 8).

With the CC, I set out to illustrate the continuity of spatial configuring and reconfiguring of boundaries between people and technologies across spaces (Barad, 2007). I intentionally begin from this conceptual framework in order to approach my research from a non-dualistic, postdigital perspective of technology, interaction, and place. Situated on an analog-digital continuum, I speculate that tracing movements across spatiotechnical configurations (Lefebvre, 1992) can highlight the emergent complexity of PBE learning, while attending to the agentic qualities of spatial production. The CC attempts to mend long-held sociotechnical divisions between analog and digital space that I have observed over my career working in learning and technology settings. For example, everyday place-based practices generally involve interacting with place through digital devices offering Google or Apple Maps (Kilday, 2018; Soukup, 2017). Together, these applications foster new methods of place learning and engagement that configure space into place. To theorize postdigital PBE, I explore how young people approach PBE activities (walking, meeting people and investigating place encounters) by intentionally incorporating mundane and emergent technologies into their environment. I then apply the CC as a framework to analyze configurations and trace learning across spatial contexts.

RATIONALE

Although I present PBE as the starting point from which I investigate the impact of spatial technologies upon place learning and knowing, my interest in this area of research stems from broader questions about technology and education. These are questions I have been asking since the beginning of my career[1] over a decade ago. Questions like, w*hy do we have computer labs?* (Trucano, 2011) *Why don't*

[1] After graduating with a M.Ed. in Education Technology (C&I) from the UW's CoE, I managed a technology center for girls in rural West Africa. Upon returning to the states in 2008, I worked with a team at USC to develop a learning platform (iwitness.usc.edu) for 8-12 grade students and teachers until 2011. After a short stint at McGraw Hill's Center for Digital Innovation in 2012, I co-founded the Center for Digital Learning and Innovation at Seattle University with two other instructional designers where I worked until 2017. During my time there, I worked with a fantastic team to design and facilitate a curriculum of course design centered around best practices in digital and hybrid education (Riesland et al., 2016). Remarkably (especially in the world of tech), these projects continue to thrive today.

we integrate technology across the curriculum to more closely reflect life? (Kimmons & Hall, 2018). *Why do finance departments, rather than educators, choose schools' technologies of learning?* (Seglem, 2015) *Why do we continually conflate content with form?* (Boczkowski & Ignacio, 2018) *Why do schools isolate students from common technology practices?* (Dreamson, 2020) *Why does education technology research focus so much on specific tools, rather than curriculum design and authentic outcomes?* (Fawns, 2018). Through years of pondering, I found myself routinely bumping up against a lot of fear. This fear, I came to learn, is rooted in the power of culture and tradition. It is a fear with a long history: Plato feared the advent of writing (Rowe, 2005). He claimed youth would become dumb if only required to read, rather than memorize and recite. Universities feared the advent of chalkboards (Davidson, 2011). What use would the lecturer serve if students need only to copy the board? Mark Bauerlein fears Google (2008), as the premise of his treatise entitled *The Dumbest Generation* reveals. Collectively, these fears have merit; I have very little of the Odyssey memorized, and I have been known to rely heavily upon the chalkboard writings of my instructors. Sadly, I use Google nearly everyday to answer a question I may have (the last being about DNA and the recent final sequencing of the genome). All joking aside, I entered grad school with the express intention of rethinking education's dysfunctional relationship with technology. I posited that given the historical recurrence of technological fears, it's worth examining exactly what we are collectively afraid of losing to new technologies that replace ways of knowing and being, which ones are worth maintaining, and how we might intentionally leverage the gains that any one technology has to offer. There is no easy way, of course, to answer any of these questions. However, the alternative is already unfolding before us.

Situating the Research

Marshall McLuhan (1964) wrote extensively about technology's ability to serve as an authority from a distance. As one of the first media theorists to consider the relational impact that different technologies had upon society, he most famously summarized his findings through the phrase "the medium is the message" (1964, p. 7). He lamented the lack of serious consideration of the technologies

of communication by theorists and the populace despite frequent "moral panic" attacks over the invasion of television. The conflation of form and content particularly troubled him with regards to the advent of "electric technology."

> The electric technology is within the gates, and we are numb, deaf, blind and mute about its encounter with the Gutenberg technology, on and through which the American way of life was formed. It is, however, no time to suggest strategies when the threat has not even been acknowledged (p. 8)

McLuhan's quote still holds true today. Electronic technology, or what I refer to throughout this dissertation as the "digital," is expanding and changing so quickly that we are collectively distracted by the *content* of the digital, and not the form ("technology") it has taken. This rapid expansion of form that has shifted from centralized one-way media boxes sitting in our living rooms to interactive connected devices in our pockets, affects every aspect of our lives. McLuhan argued that content delivery methods must be understood in order to understand how authoritative power is operating at a distance. Writing, the printing press, television, and now the Internet enact authority at a distance by shaping our collective consciousness (McLuhan, 1994; Stiegler, 1998). The focus on content is akin to a "burglar distracting a dog with a piece of meat" – the dog representing our mind according to McLuhan (1994, loc 354). Nowhere is McLuhan's analogy more apt than In learning settings, where the focus remains overwhelmingly on content. Yet now we are faced with the erosion of authority spurred by the Internet revolution and accelerated by the ubiquity of mobile devices.

Advances in communication technologies have flattened access to information while eroding trust in authority sources, resulting in a populace that can both empower and mislead itself into action (Freelon et al., 2020). This ongoing shift away from authoritative discourses (Bakhtin, 1981) that "represent a single, self-evident truth that commands assent" (McLaren, 1995, p. 25) is evident in social media rhetoric and alternative news platforms. Deemed "truth decay" by Kavanaugh and Rich (2018), the authors cite access to online media as the primary reason why so many people are unsure about information veracity,

claiming that research shows 60% of people in the United States aged 18-49 rely exclusively on digital sources to stay informed. Alarmed, educational researchers have implored educators to include information and technology literacy into curriculum (Chinn et al., 2021), despite the lack of support by national standards (Beach & Baker, 2011), and despite growing evidence that young learners lack the ability to navigate digital information spaces (Kimmons et al., 2018). Furthermore, few resources exist for preservice educators to prepare *themselves* to navigate "truth" digitally, much less the next generation (Ranschaert, 2020). In the face of "information exhaustion" and decentralization, some educational theorists have proposed re-centralizing information sources to a common distribution point (Willinsky, 1999). Echoes of tyranny aside, on some level this idea seems short-sighted after 20 years of a free and open Internet. However, upon closer examination, Willinsky's idea is already in practice through digital network protocols (Bowker & Star, 1999), where human labor is required to code information so it can be organized and delivered across networked devices:

> All this labor of moving data, content, or knowledge from one context to another – be it from past to future, discipline to discipline, or culture to culture – depends on understanding, manipulating, producing, and reproducing further descriptive, contextual information about that data, content, or knowledge (p. 7).

It is human labor that continues to build and run the digital machine we simultaneously rely upon, yet distrust to inform us. Its illusion as an authoritative discourse (Bakhtin, 1981) dispensing neutral information should have been shattered long ago. Recent research has shown that media literacy intervention for preservice teachers can only go so far to prepare them for the classroom (Ranschaert, 2020). However, the fallacy in this approach depends upon an authoritative discourse for educators to draw upon. Defined by Bakhtin (1981), authoritative discourse is information handed down by ancestors, reinscribed and couched in language that is positioned in a hierarchical stance of power. My research is premised on the assumption that authoritative discourse can only function when "unconditional

allegiance" to the source is followed (Bakhtin, 1981); therefore, the form and structure of the Internet has effectively dismantled this authority. Rather than ignore the existence of the digital realm altogether, my instructional philosophy is to explore new methodological approaches that embrace and leverage the complexity of our relationship to the analog/digital world. Portable locative technologies as well as recent advancements in augmented and virtual reality highlight the need for new methods of place-based learning and investigation (Bribri et al., 2022; Ross, 2023).

Digital Reality

One of the main ways that information decentralization has eroded trust in authoritative discourses is through the grammar of publishing. Easy access to design and editing tools has empowered non-experts to give their expert opinion. By leveraging the tools of visual design – tools that were previously only available to a select few craftsmen connected to larger information distributors – anyone with access to the Internet can participate in the practice of authoritative discourse. This lack of gatekeeping is mainly seen in the digital world, yet it affects our analog interactions. Information created entirely in the digital world can manifest in our analog lives. For example, my son recently shared an Einstein quote that his teacher posted to the overhead the other morning: "Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life thinking it is stupid." Albert Einstein has never been recorded discussing fish or trees in this context, but this oft-heard reference would seem to indicate otherwise. A quick search of this quote (Figure 2) reveals pages and pages of Instagram-postable images that erroneously attribute the quote to Einstein (the real quote is believed to come from an 1898 *Journal of Education* article resurrected in a 1994 self-help book) (Kelly, 2013). It is a lie, as the saying goes, that has been repeated enough times to be easily believed by the unsuspecting. And it is one small example of the formation of digital authoritative discourse, made possible by the democratization of information in the "post-truth" era, summarized by a single entry on your Facebook feed.

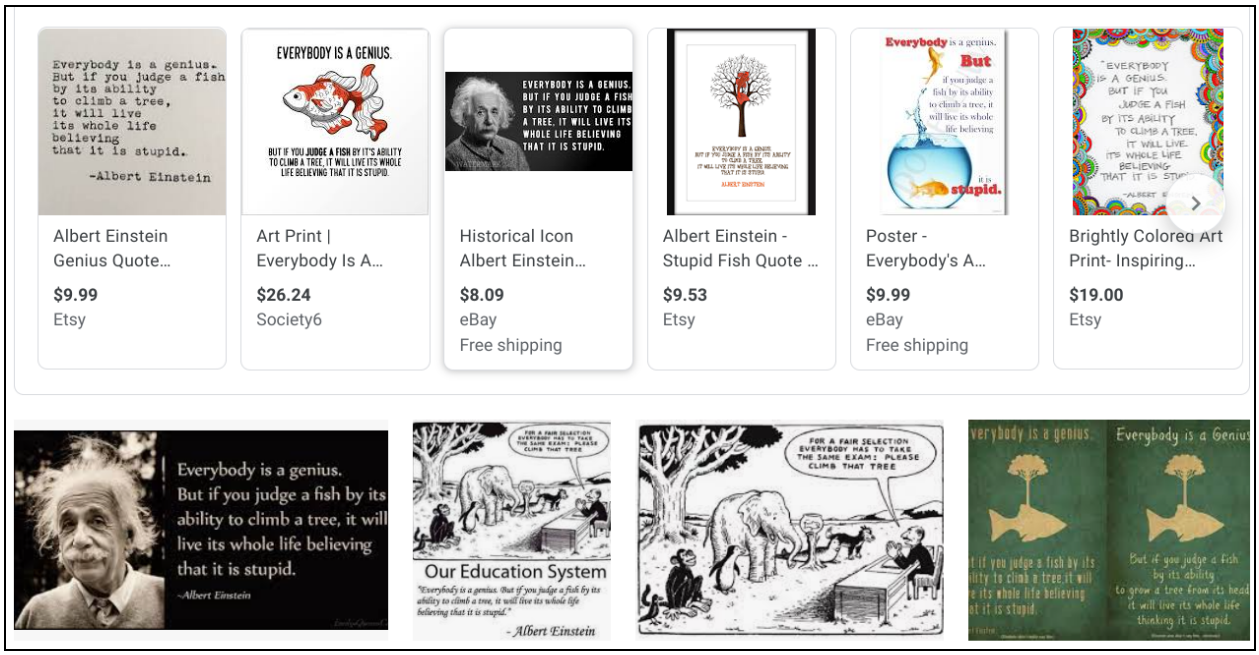


Figure 2. Misattributed Einstein quotes.

"Post-truth" was the Oxford Dictionary's word of the year in 2016 following the Trump election (Oxford, 2016). Yet misinformation and false news are nothing new (Kunda, 1990); however, what is new, and what keeps being new, is the form. Since 2016, a flurry of articles calling for "research and development to educate citizens who can reason effectively within the current post-truth landscape" (Chinn et al., 2021, p. 51) have flooded education journals. Each article cries for the need for some version of the kind of information and media literacy intervention (Hobbs, 2017) that critical digital literacy theorists have been advocating for for years (Sefton-Green et al., 2009). At some level, each response called for educators to renew their commitment to epistemic inquiry and critical thinking; however, as I argue above, this is a surface-level strategy to address the much deeper problem of assuming that technology is a neutral servant of authority, separate from human life and culture.

Positionality

My frustration with working in education technology settings for over 15 years now, stems from the problematic nature/culture division that is amplified in educational settings (Bang & Marin, 2015). What I see is the result of years of treating technology as either the source of, or answer to all of our

problems. Years of watching administrators choose technology purchases based upon hypothetical issues or innovative solutions irrespective of the practices of students and teachers impelled me to return to school and develop a new technology and education framework that more accurately reflected society. A tenet of this framework is that it accepts that we can no longer collectively "pledge blind allegiance" to an authoritative discourse (Bakhtin, 1981), and to do so is harmful in the digital age. This framework is based upon the notion that technology is part of the "real world" (Couldry, 2017), not just a tool or an accessory, but an actual integral part of life that can no longer be an afterthought in learning settings. I came to graduate school wondering what a curriculum based upon this framework might look like, and what it could tell us about the future of learning. This guiding question has driven the research trajectory that I lay out in the following three papers, and is based upon data I have collected in my ongoing quest to investigate the emergent impact of technology on learning and society.

Underlying the premise of my research are many speculative questions about what learning could be under a postdigital paradigm. Most recently, Jen Ross (2023) has called for similar challenges to existing education discourse through her book *Digital Futures for Learning*. In it, she calls for new methods for research and design that help us think about learning differently. Many of the speculative approaches explored in Ross' compendium support my interest in closing the gap between outdated research paradigms that ignore current postdigital realities. In that vein, my questions are premised on 1) creating the conditions for authentic postdigital learning, and then 2) analyzing learners engaged in PBE. Although I have been oft deemed a VR researcher, I investigate VR only in comparison mundane technology practice as a way to understand where we have been and where we are likely to go. I like to study emergent technology practices that rest at the boundaries of what we know and assume about the world, and push us to think about what is possible. I do not believe in techno-determinism and through my work I aim to surface recursivity as a hackable learning intervention of power. If collectively we understand that we make the technologies that make the world – that we are represented within them – then we have the power to disrupt what we do not want, and keep what we do (Russell, 2020). But the first step is to see the postdigital world we are operating in; and that is where I begin.

Ontological Considerations

During the years of these studies where I spent my days contemplating the role of virtual environments in learning, I struggled with the question of *what is real*? Where is that boundary? This is a question that comes up again and again through my research and it is why I created the cartographic continuum. I initially created it as a framework to think through my first round of research (Paper #2) where I first experimented with postdigital frameworks of PBE in a local environment. My research was reminiscent of the work Bill Winn and colleagues set out to do in 2006 with virtual Puget Sound. But unlike my late, great professor, I was not interested in the efficacy of an environment designed with an objective telos in mind; rather, my interest in VR stems from overlooked social, cultural and ethical considerations of building digital worlds that are not considered to be real, but are a *mediational means* (Vygotsky, 1978) with which to learn about the real world. VR made those divisions seem arbitrary to me and foregrounded the flawed premise of mediation. During my years of research, I tried to write about mediation in ways that supported a cultural tools perspective offered by Luria (1976) and Wertsch (1991) and apply it to my postdigital research, but it never quite worked. Mediation requires that there is a shared abstracted tool that acts as the means through which to know the world; but the digital VR environment was referential to itself. I could not talk about the ways VR was mediating the analog world when it was a world in itself. Yet engaging with VR impacted their understanding of the analog world, and opened them up to new ways of seeing. For example, in paper #1, Kay rewrites the car-less representation of her home of her initial paper map after visiting Google Earth VR. Upon pointing out her mom's car parked in front of her house, she returned to the VR builder to bring the car into her scene which visually resembled authoritative discourse of Google Earth. Through this small example of recursivity that I observed again and again in this data, the material agency of the digital environment continually surfaced an overarching theme that I tried to reconcile.

As I theorized the boundaries of analog/digital place engagement, by applying the CC to the data from the series of postdigital place-based curricular experiments that make up the corpus of this study, I observed youth crossing analog/digital boundaries in ways that conventional mediation theories do not

adequately address. Mediation depends upon the semiotic resources that people use to communicate through which are "treated as abstract objects of reflection rather than as embedded in the context of other forms of …action" (Wertsch, 1991, p. 39). From a postdigital lens, new materialist Karen Barad and I find this concept troubling as virtual worlds challenge "our Cartesian habits of mind, breaking down the usual visual metaphors for knowing along with its optics of mediated sight" (Barad, 2007, p. 379). "Knowledge making is not a mediated activity, despite the common refrain to the contrary. Knowing is a direct material engagement, a practice of intra-acting with the world as part of the world in its dynamic material configuring, its ongoing articulation. The entangled practices of knowing and being are material practices" (p 379). The ontological premise of this dissertation is very much found upon Baradian materialism and I was relieved to find her work as it answered many of the underlying questions I was struggling with in my research. In these three papers, I use the term "interaction" to describe the entanglement between learners and place for simplicity's sake although "intra-action" would be more accurate. Interactions assume agency lies only with the actor while intra-actions refer to the mutual co-creation of material boundaries between learner and the environment. Although I do not directly address these concerns head-on through my research questions, the findings from my three-papers support Barad's ontological orientation and subsequent theories of mediation and materiality. I intentionally position place as part of the analog/digital continuum to begin to address the false dichotomies of *real* and *virtual* that trivialize the role of the digital in our daily lives.

Research Questions

In this dissertation, I take on place-based education (Sobel, 2005) through a series of what I call postdigital curricular design experiments (Cobb et al., 2003) premised upon the idea that technologies of place are part of place and should therefore be included in place-based education. I ask, *what if we designed a curriculum based upon the premise that technology is part of the "real world" rather than separate from it?* The three papers I present here attempt to answer this question through findings from the following three studies:

Paper One

The Cartographic Continuum: Investigating Analog/Digital Boundaries

Question: *How are young people learning about local place and community across analog and digital boundaries?*

Method: I propose a methodological framework called the cartographic continuum to analyze data of young learners engaged in a local postdigital PBE curricula.

Analytic approach: By applying the framework to analyze data collected during the ten-week PBE curriculum, I identify material qualities of each configuration and then trace PBE engagement across analog/digital boundaries.

Main Finding: Youth replicated visual representations provided by the digital environment in ways that both reinscribed and challenged existing place narratives.

Paper Two

Towards Historically Effected Consciousness: A Postdigital Pedagogy of Place

Question: *What might a postdigital place-based curriculum look like? What would young people learn from it?*

Method: I apply a heterogeneous approach to PBE by incorporating multiple analog and digital encounters of a local waterway named after the area's indigenous residents through an undergraduate course on informal learning.

Analytic approach: After collecting GoPro video data across settings, I identified evidence of claiming moments, or moments when youth were taken by surprise. I then cross-referenced these findings with assigned written reflections to identify thematic findings.

Main Finding: *Interpretive Distance* indicated through claiming moments (Gadamer, 2013) elicited critical reflection and inquiry into place, history and representational knowledge, further supporting evidence of *historically effected consciousness* (Gadamer, 2013) in learners made possible through a postdigital PBE curriculum.

Paper Three

Learning along Postdigital Lines: Chronopaths

Question: *How do young people learn along lines in visually rich, cinematic digital geographies? How do they learn along postdigital lines?*

Method: I follow youth as they learn about local and familiar places through digital geographies (Google Earth VR and desktop).

Analytic approach: Using only screen recordings of first-person point-of-view video, I follow youth along *lines of learning* (Taylor, 2017) which I extract through the series of visual frames to produce lines of travel made in Google Earth. I then use rhythmanalysis (Lefebvre, 2017) to compare line patterns which I code according to temporal interactions.

Main Finding: Different material configurations of Google Earth produced three types of lines called chronopaths: chrono-cruising, chrono-walking, and chrono-dropping. Patterns in movement correlated with learners' spatiotemporal engagement (Lefebvre, 2004).

Together, these papers address: *What could we learn from designing postdigital place learning encounters, and how could we analyze observations of learners engaged in these designs? What might findings from postdigital place-based design tell us about the future of learning?*

RESEARCH CONTEXT

To explore my questions, I sought to design a set of curriculum design experiments (Cobb et al., 2003) that I could iterate upon later with participants based upon my findings. The flexible design of these experiments were centered in what I called postdigital place-based learning, but could be applied to other place-related contexts. Each curriculum design experiment was designed to elicit *interpretive distance* (Gadamer, 2013) through heterogenous encounters of place perspectives (Haraway, 1992). By design, the curriculum presented an array of familiar analog and digital place configurations stabilized through the

digital geography of Google Earth. Young participants were regularly asked to explore digitized renditions of local and/or culturally familiar places through Google Earth immersively (VR) or through windowed environments (smartphones, laptops, and desktops).

The design-based research (DBR) study (Gutiérrez, 2017; Bell, 2004) presented in the corpus of this dissertation is the culmination of three rounds of data based off of three iterations of postdigital place learning. The curriculum presented in this study is based upon a postdigital approach to place-based learning across the continuum. Each round of curriculum was designed to address the overarching motivations and interests of the participating learners while learning about place. Although curricular activities differed in scope and purpose across these three studies, they share an overarching concern with how differing technical configurations informed learner interactions and subsequent insights of place. Building upon the results of the initial cross-modal, diffractive (Barad, 2007) place-based curriculum, I follow young learners as they navigate place across multiple analog-digital configurations.

CONTRIBUTIONS OF THE THREE PAPERS

In these three papers, I explore what I theorize are the possibilities of postdigital place-based learning. Postdigital theory closely aligns with relational pedagogies that support the dynamic interconnectedness of the learner and the environment (Macgilchrist, 2021). Rather than being bound to pre-existing discrete units, the learner and the environment develop in a symbiotic process of co-constitution (Haraway, 2017); i.e., one is not made without the other. I intentionally include the digital environment to foreground what is missing in current place-based approaches to learning and engagement. Place is made up of many stories and many perspectives co-constituted with people, technologies and geographies that I argue must be included in PBE if we are to teach about the world we *actually* live in rather than just the one we would like people to *believe* in. To do so requires embracing an ontology that supports the multiplicity of places (Massey, 2005) and its shifting boundaries across its many analog/digital components. Vygotskian theories of mediation break down when the tools to study the environment become the environment.

From a postdigital stance, to exclude digital geographies and technologies diminishes the role of authentic digital place-based practices (boyd, 2005) that occur in everyday place encounters. Situated in the contextual vacuum of current digital pedagogical practices (Collins, 2019), these papers argue that by excluding digital place engagement educators risk reinscribing dominant, single-story narratives. By that same token, PBE educators miss out on opportunities to engage in critical discourse with digital geographies as they become increasingly prevalent. Through my research experimenting with postdigital PBE pedagogies, I found that my findings supported an agential realist ontology (Barad, 2007) that I argue is more aligned with the postdigital world we actually live in rather than the tradition of Western epistemology that dominant theories of learning are founded upon. My postdigital findings supported the following agential realist claims:

1. The cartographic continuum revealed how spatial analog/digital configurations co-constitute spatial boundaries that have *agential,* recursively-material consequences to place learning and identity.
2. Undergraduates came to understand place through *diffraction,* or by comparing similar yet heterogeneous perspectives (Haraway, 1988) that surface hidden prejudices (what they did not know they did not know). Learners critically evaluated differences while establishing similarities between encounters.
3. Learners *intra-acted* with digital geographies to co-constitute place boundaries that "matter[ed] to the making/marking of space and time" (Barad, 2007, p. 180). Young learners' intra-actions along lines of digital movement to produce temporality demonstrated the material affordances between different sociotechnical (Leonardi, 2012) configurations of Google Earth.

Barad (2007) refers to these agential realist processes as "world-becoming," a relational process wherein people are in a constant state of making and remaking sociomaterial boundaries. She theorizes that our ontological epistemological orientation comes from ethical and political stances that inform this

fluctuating boundary-making process. Findings across my three papers demonstrate how a postdigital learning design pedagogy supports learners in a process of "world-becoming" rather than one that emphasizes a separative process of "world-knowing" (Barad, 2007). Youth engaged through digital encounters of their neighborhood found opportunities to take up, reject and contribute to their own place identities thereby creating their own boundaries between self and world.

The young people featured in these studies were challenged to engage with local and familiar places across different analog and digital configurations. I integrated authentic digital place-based practices alongside novel and traditional place-based pedagogies through a series of curricular design experiments (Cobb et al., 2003; Bell, 2004). In these papers, I describe situations where youth learn about spaces and places through, alongside, and with mundane and novel technologies in conventional and emergent analog/digital configurations (e.g., computer, smartphone, VR & AR). Google Earth served as the connector across contexts (Lave, 1991) and so I routinely highlight its material qualities and its impact upon youth learning in my analysis. The data I collected come from activities where I asked youth to use Google Earth to explore, ponder, reconcile and consider digital renditions of familiar analog experiences in ways similar to how they would naturally engage with Google Earth when left to their own devices (Danby, 2015; Silvis, 2018). While I set out with postdigital intentions, I relentlessly attended to the interests of youth to see how they were organically taking up digital geographies across various spatiotechnical configurations of devices and places. An overarching finding echoes across my data: everyone wanted to go home. I wondered *Why would young people want to explore digital renditions of their house when they could simply walk out the door and see it in person?*

I believe this question gets at the heart of the current digital climate in which we we find ourselves. If we suppose that tools are simply a way to *know* the world, what is Google Earth teaching youth that they do not already know? In traditional, reflexive pedagogies, Google Earth would be the stable representation of place that is memorized and used as a semiotic resource (Goodwin, 2018) to describe concrete, analog realities like the orientation of the city, and the number of blocks to a friends' house – a map in other words. But Google Earth is not really a map (or not *only* a map), and it is not the

analog world either; it is something in-between. The in-between is where postdigital learning lives as it acknowledges that the digital is *us*, and *we* are the digital in the same ways technologies are not separate, but part of the world (Jandrić, 2017; 2021). Barad would argue this epistemological stance is political in nature as it gives agentic power to the environments we create (2008). For example, Google Earth does not render or collect Street View imagery of all cities. Through simulation, it renders roads but not traffic, shops but not homeless encampments, houses but not people. Through exclusion, Google Earth renders the world in a contextual vacuum where what is made legible is privileged over what is not. Yet digital maps like Google Earth are positioned as neutral models of the analog world (Ash & Kitchin, 2013) that through representation (or the absence of representation), teach people about what is important, and what is worth their attention.

The findings and analysis I present in these three studies highlight the impact of digital agency and the digital environment upon place-based learning outcomes. Overall, I argue that to ignore digital agency and take on a separatist, emancipatory view of learning design – one that strips digital realities from curricular content – is to leave youth largely unprepared to be discerning, participatory members of the world they are becoming (Barad, 2007).

PAPER ONE: **THE CARTOGRAPHIC CONTINUUM**

Introduction

In 1992 science fiction author Neil Stephenson released the book *Snow Crash*, a tale of young people living in storage units that they regularly escape the confines of by connecting to the digital "Metaverse." As a youngster reading *Snow Crash* in the early days of the Internet, I was simultaneously disturbed by the dystopian future that the author invited us to ponder, yet found myself enamored by the idea of an alternate world where it was possible to break free of the limitations of gender and identity. *Snow Crash* followed in the footsteps of Haraway's Cyborg Manifesto (1985), and was released when Legacy Russell was discovering who she could be in AOL chat rooms where her skin and sexuality were identities she could explore outside of her midwestern town (2020). In *Glitch Feminism* (2020), Russell writes of this promise of the Internet that we both came of age in:

> We want a new framework and for this framework, we want new skin. The digital world provides a potential space where this can play out. Through the digital, we make new worlds and dare to modify our own. (p. 10)

Yet, as we all know, these new digital worlds bring a level of complexity that we are collectively navigating, and it is in the complexity that I ask the reader to consider new methods of learning and engagement aimed towards a future we want, rather than blindly marching towards the future Stephenson warned us about.

What separates the analog from the digital world? And what do traditional spatial and learning practices have to tell us about the future of digital place-based learning (Ross, 2023)? What methods might we employ to think through the emergent relationship between analog and digital engagement? And how might we begin to address these new challenges through education design and research? These broad, overarching questions informed several years of my dissertation research and are resurrected here as a lens through which to think about the making of place through analog/digital

spatial engagement and learning. To begin to answer these questions, I followed young people as they learned about familiar places across analog and digital boundaries. The curriculum I co-designed with youth (Gutiérrez, 2008) incorporated mundane and emergent spatial technology practices alongside place-based learning pedagogies (Greenwood, 2008). Findings from this experimental curriculum (Cobb et al., 2003) prompted the need for new analytical frameworks that spanned analog/digital place contexts.

After several years of place-based research dedicated to investigating how young learners navigate analog/digital boundaries, I have accumulated videos, screen recordings and digital maps of youth traversing these boundaries with no real way to analyze learning across analog/digital contexts. I observed young people excitedly exploring their digital homes and neighborhoods in Google Earth in virtual reality (VR) and on their desktop computer. Coupled with outdoor scavenger hunts around the analog neighborhood, they used the social mapping app, Siftr, to share images of themselves, and what they had found and where in their neighborhood. These commonplace interactions between analog places and location-aware devices connected to shared digital geographies are quite commonplace now, yet regularly overlooked as part of place learning and engagement (Dourish, 2004). I used these digital devices to explore how the materiality of digital devices affects learning across place contexts. When looking for resources that could help me describe learning across contexts, I found that devices are often positioned as neutral tools to learn about places separate from the "natural" analog environment (Knox, 2020; Gourlay, 2021). Yet watching young people negotiate analog neighborhood experiences through digital devices and Google Earth explorations, the entanglement between the digital and analog environment became apparent. Within my data, I wondered how learners were crossing boundaries and stabilizing place contexts; in other words, *what was the digital environment teaching them about the analog and vice-versa?*

Digital agency

We know from sociocultural research that the environment plays an important role in every aspect of learning, knowing and being (Vygotsky, 1978); yet little research has considered the agentic role of *digital* engagement as part of the sociocultural learning environment (boyd, 2014), particularly with regard to place-based learning (Greenwood, 2015). Most VR research has focused on learner efficacy (Bailenson, 2018) rather than its agentic role in place-based sensemaking. For example, a research study that compared Google Earth VR field trips to analog encounters showed similar or better learning outcomes (Parsons et al., 2019). In fact, most VR-related educational research has demonstrated better learning outcomes than those performed in the analog world (Bailenson, 2018) and are "particularly effective for learning complex systems" (Lee & Dalgarno, 2009, p. 10). Simplified and abstracted simulations lead to better learning outcomes by reducing cognitive load (Clark, 1983); this has long been known. But what about simplified constructions of the complicated analog world? The implicit neutrality of cartography (Harley, 2001), and technology more broadly (Haraway, 1985; Latour, 1987; Wajcman, 2004), underpin the assumption of Google Earth as an accurate representation of the analog environment. Yet the level of abstraction – the reduction of complexity – comes with its own learning agenda. Overwhelmingly the youth I observed in VR were *moved* both literally and figuratively. Upon entering the simulation, one youth in the study, Kay, held up her hands and exclaimed "Jesus take the wheel!" It was clear from my data that the materiality of spatiotechnical systems was impacting place-based learning and interaction. To understand what was happening, I needed a way to follow learners across spatial contexts in a way that could describe the impact of analog/digital boundaries as they learned about place.

Introducing the Cartographic Continuum

To answer these questions, I present the *Cartographic Continuum* (CC) as an analytical framework to consider the sociomaterial configurations that make up place-based learning and engagement. Drawing upon the work of digital geographers whose research considers the social and technical relationships

between digital and analog space (Elwood & Leszczynski, 2010; Kitchin, 2014; Chapple et al., 2021), I propose this analytical framework to highlight the material agency of spatiotechnical configurations that people use to learn about spaces and places. I designed the framework to consider the materiality of learning configurations, and in doing so, I aim to foreground the effects of the digital environment and the devices we use to connect, access and learn about places and spaces. In considering the material entanglements of learners and technologies, the CC identifies boundaries situated within spatial interactions (Goodwin, 2017; Suchman, 1985). As boundaries shift across configurations, the CC serves as a tool to trace across analog and digital contexts. By analyzing how learners participate in place-based activities that intentionally include mundane and novel digital practices, I gain insights into the emergent tensions and possibilities of learning through and with the digital environment. In applying the CC as an analytical framework, I ask *How are sociomaterial and technical configurations changing the production of place and learner identity? What tensions and possibilities are made available through this process?*

Background

This work sits at a controversial intersection where parents and educators lament the loss of childhood to the attention economy and ward young people against the dangers of screen addiction (Twenge & Campbell, 2018). At the same time, new media ecologies continue to support emergent communication and identity practices built upon platforms with dubious origins (Citton, 2017). As I write this introduction, Meta (Facebook) is being sued by Seattle Public Schools (Yang, 2023) and TikTok is being investigated by congress (Chander, 2022). To be sure, there are many reasons to be wary of the digital; yet I fear the apathetic resignation of educators and researchers who by collectively throwing up their hands will, by default, give the digital future over to corporate interests.

My interest in sociotechnical systems (Suchman, 2007) and spatial learning began with much of the same optimism that Haraway (1988) and Russell (2020) wrote about: speculative future worlds where new identities could be transcended, explored and embraced. However, the rhetoric around these

worlds (or as McLuhan (1964) would call it, *our world*) has changed very little from one steeped in fear and preventative measures to protect young people from technology's insidious influence as outlined in the COPPA and DOPA acts of the late 90s (boyd, 2014). These sentiments go deep: Bill Gates and Steve Jobs famously raised their children technology-free, giving their children time for activities like equestrianism and dinner-time lecture series (Isaacson, 2020; Winnicott & Matilda, 2017). Silicon Valley is rife with tech leaders who send their children to experiential tech-free schools that embrace the surrounding Bay Area wilderness (Bowles, 2018). These examples from the elite members of digital society beautifully demonstrate the underlying tension the contemporary world finds itself in: unevenly distributed access to privileged discourses, green spaces, and cultural enrichment. The Internet was founded upon an idea of open access to combat unequal hierarchies (Lessig, 2004), but exclusionary educational policies that limit access through schooling further marginalize the already marginalized. Exclusionary school policies limit opportunities for the already marginalized to explore possible futures and identities. Digital exclusion ignores the emancipatory qualities of the Internet; over its promise of a place where people can transcend race, class and gender to imagine something new. Founded upon solid principles of freedom, the Internet has over time replicated the consumerist, attention economy that exists in the analog world (Citton, 2017). The digital systems we have been offered are built upon imperfect systems, true. But they still matter in big ways and have the potential to make a big impact on issues of social justice. Legacy Russell (2020) advocates for us to *remix* the materials we have been given:

> We are faced with the reality that we will never be given the keys to a utopia architected by hegemony. Instead, we have been tasked with building the world(s) we want to live in, a most difficult yet most urgent blueprint to realize. If we see culture, society, and, by extension, gender as materials to remix, we can acknowledge these things as "original recordings" that were not created to liberate us. Still, they are materials that can be reclaimed, rearranged, repurposed, and rebirthed toward an emancipatory enterprise, creating new "records" through radical action (p.132).

I advocate for the material resources offered through platforms, geographies, and digital discourses in the same way I advocate for learning and teaching about the world we *actually* live in and not the one we, or a privileged few pretend we live in. New and good things *can* be built upon faulty foundations to advocate for better, more emancipatory futures. For better or worse, social media has amplified voices that would not otherwise have been heard (Russell, 2020):

> This world is not built for us; yet still, somehow, we are here, standing against all odds. Similarly, the Internet, an electrifying black mirror, was not built as material for our bodies. At its worst, it only reflects back to us the misery of the world around us. Still, we create opportunity for fugitivity in our deployment of digital material. Online, we magnify our avatars, our vast and varied selves (p. 133).

As the convergence of geography, digital geography, AR and VR begin to further transform everyday spatial encounters, I argue for place-based pedagogical methods that embrace the materiality of digital emergence and employ them as resources to create possible futures with thereby challenging underlying inequities. To exclude the digital is to position citizens as uncritical consumers of tech rather than as discerning creators and authors of our digital worlds. Towards that end, I propose adopting the CC as a framework that foregrounds material resources that highlight tensions and possibilities as learners configure space to produce place-based identities.

Developing the Cartographic Continuum

The CC developed out of a need to trace the interactions of young people as they learned in places that spanned analog and digital engagement. I observed young learners engaged in place-based learning that was on a scale between analog and digital; rarely one side or the other. At the same time, the analog and digital were always in conversation with one another through their PBE engagement; participants relied upon the renderings of Google Earth which they took up, remixed or otherwise confronted through spatial technologies. As I set out to analyze how youth engaged with their home

and community through mundane and emergent technology practices, I discovered the complexity of tracing interactions across spatial representations. Youth moved between analog and digital contexts while interacting with places like their home via a plethora of material configurations (handheld smart phones, digital browsers, and immersive VR headsets). In the words of David Harvey (1996), I felt I would be in "serious danger" if I proceeded in my analysis as if "material and absolute space did not matter" (p. 308). At the same time, the materiality of the digital impacted how youth were engaging across analog and digital configurations of the neighborhood. After observing hours of youth exploring their community in virtual reality rendered by Google Earth which is simulated from satellite imagery and user-generated images, connected to Google Maps and location-aware devices that run on Android (a Google product) and available in every data-connected smartphone within range of a cell tower on the planet (Kilday, 2018), I began to more closely attend to agency of the digital environment through the interactions of youth. Youth could fly over their digital neighborhood and walk through connected panoramas. Wearing responsive immersive headsets, youth could crawl on the ground, point, travel and ponder. "Absolute" analog space was rendered through a digital model that liberated and revealed possibilities not possible in their analog lives. In applying the CC to this data, I capture the material elements of digital geographies, trace its transformation across boundaries and consider their material role in place-based learning.

Based upon how young people use technology to engage with and learn about places, I premised the CC upon observations of youth negotiating along an analog and digital continuum. Interacting between two extremes, through observations I noted how interactions recursively informed the other. Youth constantly referenced digital cartographies while capturing location-based imagery, contributing to social mapping and exploring through Google Earth. By constructing a framework that explores the analog/digital continuum, I wanted to observe how the CC demonstrates that place-based learning rarely relies on only one side of the continuum despite conventional place-based methods. For that reason, the CC highlights the need for new methods of learning about place (and beyond) that

consider the material agency of digital geographies and emergent configurations of place, thus foregrounding the agency of the environment and its role in PBE learning and teaching.

I show how the CC functions across learning contexts by first making a case for postdigital PBE, and then introducing the CC by outlining the theoretical and historical foundations. To illustrate its function, I analyze a postdigital PBE case study where I follow youth as they interact with place across a variety of digital geographies. Through this postdigital PBE case study, I illustrate how the CC can be used to trace material agency across digital configurations that demonstrate how boundaries are replicated and challenged by young learners. Findings revealed through the CC highlight the hidden agency of each analog/digital configuration and its subsequent effects on PBE. Throughout my analysis across the CC, I considered the materiality of digital configurations as resources for young people to take up, consider and/or refute.

The cartograph continuum: a rationale for digital place-based education

Spatial technologies like Google Maps, Google Earth and Google Earth VR blur the lines between binaries that show up in popular discourse; i.e., online/offline (Jurgenson, 2011), analog/digital (Farman, 2012), and even real/unreal (Ivanov, 2000). These technologies have been around for more than twenty years now, and have been embedded into our smartphones for more than ten (Kilday, 2018). Built upon satellite imagery, driverless cars, and networked crowd-sourcing, these digital maps form the foundation of a multitude of location-aware technologies that contextualize our experiences of place (Kilday, 2018). However, little is known about how children come to conceive place through everyday digital encounters, much less through the rapid emergence of these spatial technologies (Hall et al., 2020). As the complexity of spatial encounters and interactions grows with the advent of new technologies, children's understanding and knowing of place becomes more complex as well. Whether gazing down at an aerial view of a familiar neighborhood in Google Maps, or discerning the direction of the nearest Pokemon stop, children's spatial technologies increasingly inform and configure their conceptions of place and identity.

Postdigital PBE and the Cartographic Continuum

Despite these changes, PBE practices have largely ignored the role of spatial technologies in children's sense-making of place and tend to position technology as a hindrance to PBE rather than an asset or integral aspect of it (Sobel, 2013). In Greenwood's 2007 treatise on critical PBE, he addresses PBE uses of technology, while positioning it as an accessory to place, claiming that technology "...limits, devalues, and distorts local geographical experience" (Greenwood, 2007, p. 8). Rather than side-step the existence of spatial technologies altogether, this curriculum I analyze through the CC investigates a *postdigital* (Jandrić, 2018) approach to PBE. Postdigital education positions technology as an integral part of learning rather than a novelty or obstacle, thereby returning the focus back on learning processes and outcomes (Knox, 2019). In this methodological proposal, I follow two middle school-aged children as they configure place through a postdigital place curriculum that leverages a variety of mundane and novel spatial technologies centered around investigations into their home and community. The CC highlights the material impacts of their analog/digital boundary crossings and demonstrates how digital practices underpin PBE engagement regardless of its explicit pedagogical inclusion (Knox, 2019).

The Cartographic Continuum and the sociomateriality of places

Socially situated technical systems continue to diversify, expand and configure with places and spaces (Farman, 2012). The ubiquity of location-aware and environment-aware applications available on handheld smartphones have presented unique opportunities to mobilize learning into local communities and contexts (Marin et al., 2020). As technologies transforms, the CC transforms as well as a way to account for the emergent corpus of spatial configurations that contextualize and organize spaces and places. Currently, portable location-aware smartphone systems range between providing a "window" into analog space where objects and information appear on the screen as embedded into the environment (e.g., Pokemon Go). Wearable heads-up displays (HUDs) like Google Glass, or Microsoft's Hololens attempt to provide a seamless experience of place where digital objects appear to exist in the analog environment.

These augmented reality (AR) experiences vary in scope and purpose, but are all designed to bring digital elements into the analog environment (e.g., Farman, 2012). The CC considers the material form and function of individual configurations and how people use them to co-constitute space. For example, an augmented reality experience is considered to be mixed reality (MR) when interaction and hand-tracking is enabled through the HUD, effectively layering upon the existing analog environment. The CC considers the material implications of this kind of engagement and places the learning experience along the continuum. Fully immersive digital experiences require a head-mounted display (HMD) to create an immersive virtual reality and are placed on the extreme digital end of the CC. Although many of these more intricate emergent technologies have yet to achieve the level of everyday usage of the smartphone, the underlying ramifications of shifting analog and digital spatial boundaries persist. In this article, we argue that these boundaries are continually configured and reconfigured between children and technology, and have long been left out of place-based education (PBE) and learning.

Place-based education and the cartographic continuum

PBE originated from educational practices centered around environmental stewardship and citizen responsibility (Sobel, 2004). The Nature Studies movement of the 20th century, from which PBE was founded, was based upon learning about and understanding the untamed "natural" world. As environmental concerns grew into public awareness, learners were taught about rainforest destruction and ecosystem breakdowns, partly to engender stewardship and raise awareness of global environmental concerns, but also to teach people about the destructive forces of a capitalistic society. Place-based learning gained popularity as a way to engage learners with/in their local communities; however, the foundation of dichotomized nature-culture constructs (Bang et al, 2013) continues to underscore its curricular aims and centers analog definitions of place irrespective of digital influences (Greenwood & Hougham, 2015). The CC seeks to surface the agentic qualities of the material environment by foregrounding relational configurations of the learner and the environment.

PBE advocates for curriculum design that addresses concerns of everyday life through activities that contribute to community cohesion (Smith, 2002; Sobel, 2005). PBE stresses interdisciplinary concepts embedded within local systems, histories, and interactions. Researchers adopt PBE (Lim & Calabrese Barton, 2006) to transform abstract knowledge to local knowledge related to communities' cultural practices (Gruenewald, 2003). For example, Semken (2005) offers an applied PBE framework designed for science learning that: 1) examines the natural history of place; 2) attends to its diverse meanings within community; 3) investigates authentic artifacts; and 4) encourages ecological sustainability through project-based opportunities to strengthen personal relationships to place. Spatiotechnical configurations of people and places contribute to knowledge production and dissemination which the CC is designed to account for through PBE encounters.

Critics of place-based learning argue that pre-determined outcomes, typical in classroom instruction, drive instructional design, thus ignoring the underlying relationality of true place engagement (Nespor, 2008). Although PBE's roots are in environmental education, current research extends beyond false dichotomies of the "natural" versus "urban" world, and "human" versus "nature," for instance. The advent of new VR technologies has renewed interest in representations of place, spawning new lines of inquiry into virtual PBE (Lansiquot & Macdonald, 2019). Such inquiry includes VR's phenomenological role in place learning (Park, 2019) and fieldtrip alternatives (Parsons et al., 2019; Hamilton et al., 2021) but fails to distinguish between differences in material engagement between analog and digital encounters. The CC highlights the material resources of the learning environment (Shea & Sandoval, 2020) across spatial configurations thereby making relationships visible, and surfacing underlying power structures embedded within spatial contexts.

Digitally immersive place-based learning with VR and other spatiotechnical configurations call for renewed thinking about disparities in place and place education where forgone conclusions about neighborhood and/or location, for instance, can be prepackaged and delivered in digital form (Park, 2011). We can see these disparities in Google's treatment of cities within Google Earth VR and Street View; some cities contain rich immersive 360º photography to explore, while others have none. Some locations

offer increasingly detailed labeling as the viewer zooms in while other locations have no labels regardless of scale. These discrepancies lead to inequitable opportunities for spatial sense-making and are often obscured by assumptions of representational accuracy. From a materials perspective, the CC considers the agency of underlying digital geographies and their contribution to PBE.

Proposal for a new analytic framework

Given the need for renewed methodologies of PBE that extend beyond outdated nature/culture dichotomies (Bang, 2015), *what might postdigital PBE look like – and how could I analyze it?* In this article, I present data from a curricular design experiment (Cobb et al., 2003; Gutiérrez, 2018) investigating children's place interactions across multiple configurations of space and technology. I posit that this curriculum is postdigital in that it intentionally presents investigations of place across a multitude of analog and digital technologies. Recently, Parsons et al. (2019) concluded that virtual field trips in Google Earth VR resulted in learning outcomes on par with analog experience. This study implicitly questions these findings by encouraging children to explore the analog world they are familiar with through the digital lens of Google Earth and Google Street View. In order to trace across spatiotechnical configurations, I developed an analytical framework, called the CC, to identify children's learning-in-place with/through technologies. Rather than adhering to what is real or not, the CC situates spatial interactions on a continuum between analog and digital, thus acknowledging the central role that digital technologies play in conveying spatial concepts and understanding. By focusing on spatial configurations made possible through digital technologies rather than on slippery renditions of so-called "reality," we move closer to postdigital PBE.

Milgram et al's., "Three-Dimensional Taxonomy" place spatial technologies on a continuum similar to the Cartographic Continuum, called the "reality-virtual (RV) continuum:

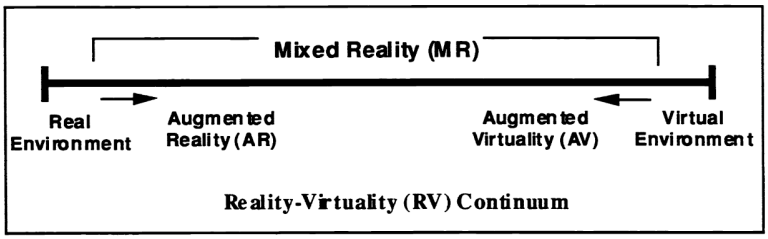


Figure 1. The Reality-Virtual Continuum (Milgram et al., 1994)

I developed the CC out of traditional cartographic conceptions of the CC as noted above (Figure 1) and the RV continuum. The CC as presented here (Figure 2) is centered around the emergent relationship between analog and digital spatial configurations.

ANALOG –> MIXED –> DIGITAL

	Analog	Digital Analog	Layered Digital	Augmented Digital	Mixed Digital	Immersive Digital
Material Configuration	Analog	Window-Into Place *Computer*	Window-Informing Place *Mobile Device*	Window-Inscribing Place *Mobile Device*	Heads-up display (HUD)	Head-mounted display (HMD)
Place experienced via:	the "real" world	cartographic representations	location-aware assistance	rendered objects	immersively rendered objects	the immersively virtual world
Common Examples	written guides, static maps	interactive digital maps (Google Earth/Maps, etc.)	GPS navigation, Navigation apps (Google Maps, etc.)	AR apps (Pokemon Go, Starchart, etc.)	AR glasses (Google Glass, MS Hololens, etc.)	VR headset/application setup (Oculus, HTC Vive)

Figure 2. The six configurations of the cartographic continuum.

In the RV continuum, Milgram et al., refers to the kind of AR that happens through non-immersive screens as a "window-on-world." The effect is similar to playing PokemonGo, where

digital renditions of space appear on the smartphone screen appearing as if sharing they interact with the analog space, sometimes with another PokemonGo player. The CC applies the "window-on-world" metaphor to the different types of technologies configuring place. A digital analog configuration of place leverages the computer screen as a "window-into-place." Throughout the postdigital PBE curriculum, youth returned to this configuration to bridge and contribute to place configurations, usually over a laptop Chrome computer running a VR construction program. Smartphones are considered *layered digital* configurations of place designed to contextualize the analog world, thereby creating a "window-informing-place." Augmented reality like *Pokemon Go* demonstrates how smartphones can be transformed into a "window-inscribing-world" (Figure 2). These portable windows bridge analog and digital place learning across contexts (Lave, 1991) and through configurations that provide new methods for learners to learn and engage with place. Overall, the purpose of the CC is to think through material the agency of different spatiotechnical configurations and how interactions contribute to learning and engagement.

Case Study Summary

I follow two youth – Kay and Zee – as they navigate a postdigital PBE curriculum to configure and reconfigure technology and space into place meaning and engagement. Using the CC to distinguish between material configurations of learners and spatiotechnical devices, I present Kay and Zee's PBE learning across the analog and digital neighborhood via artifact capture, screen recordings, and GoPro video as they traversed the analog/digital continuum. To demonstrate traces across the CC, I begin with the girls' ten-week curriculum which commenced on the extreme analog-end of the CC by describing their visual depiction of their "daily round" (Taylor, 2017). Using their analog maps as a baseline, I follow the girls over the next several weeks as they learn in places along the continuum and attend to their material interactions as they participate in a PBE curriculum centered around their home and neighborhood. Tasked with completing a series of team-based smartphone-led scavenger hunts that required image and panorama collecting to add to their VR creative spaces, Kay and Zee regularly crossed

analog/digital boundaries as they completed tasks in analog and digital spaces. By attending to the material aspects (embodied engagement, visual experience, and tacit interactions) made possible through the devices that enabled the youth to negotiate the two ends of the continuum, I gained insight into how Kay and Zee's interacted with them to produce place. Over the ten-week curriculum, I noted which representational place-based resources were deemed important by the girls and how they engaged with and learned from them. As I followed the girls' interactions with the spatiotechnical systems featured in this study (smartphones, Google Earth VR, Siftr and Google Maps), I used the CC to trace how youth adopted, confronted or overlooked digital representations that impacted place learning. By foregrounding the representations that Kay and Zee took up through their postdigital PBE curriculum, I highlight the transformation and replication of their representations across the analog/digital environment.

Research Context

The curriculum featured in this study was part of a ten-week afterschool Science, Technology, Engineering, (Arts) and Mathematics (STE(A)M) program centered around local place-engagement. Called STUDIO, Kay and Zee were long-time consenting youth participants of this research-practice partnership between the University of Washington and a Neighborhood House community center (Herrenkohl, et al., 2019; Lee, 2023; Taylor, et al., 2022). STUDIO "designs and studies out-of-school time STE(A)M programming for Immigrant and/or refugee youth" (Taylor et al., in press) living in a Hope VI housing community in Seattle. University of Washington undergraduates majoring in STEM-related fields work with middle and high school-aged youth to explore science and technology concepts. Working with the STUDIO team as a researcher/designer, I had the opportunity to collaborate with youth at STUDIO to develop and facilitate two 10-week postdigital PBE programs based upon local community exploration and engagement. Although roughly 15 middle-school aged youth attended STUDIO on a semi-regular basis, Kay and Zee were chosen for this case study because of their consistent level of engagement throughout the ten-week program. The emergent themes, patterns of engagement,

and interactions I observed through Kay and Zee are representative of broader themes I observed across STUDIO participants.

Curriculum

The foundational design of this curriculum was derived from "learning-on-the-move" pedagogies (Hall & Taylor, 2013) and Taylor's (2017) Mobile City Science (MCS) curriculum. Drawing upon the results from earlier, less formal postdigital PBE experiments, I situated this curriculum within an MCS framework where youth were challenged to observe, engage, and learn about their local environment with locative devices. As part of participatory design framework (Gutiérrez, 2016), I collaborated with youth, STUDIO staff and my research partner to develop a ten-week postdigital PBE curriculum (Figure 3) that challenged young learners to engage, learn, and create through analog and digital neighborhood encounters.

Spatiotechnical Configurations

Spatial encounters were designed to span the CC through configurations of learners and technologies. While all configurations of the CC (Figure 2) were touched upon through various activities, only *analog* (paper mapping), *digital analog* (stationary screens), *layered digital* (smartphones), and *immersive digital* (VR) are described in the study per their location on the CC. Drawing upon learners' locative literacies (Taylor, 2017), I integrated spatial technologies across the curriculum so youth could engage with the community through multiple analog/digital pathways. Participants began with analog engagement by first mapping their analog "daily round" (Taylor, 2017) on paper the first week. Paper maps served as the baseline spatial model of learners' spatial understanding. We asked youth to depict important locations in relation to home, and indicate their method of travel to reach these locations. In the following weeks, youth explored the neighborhood with smartphones, or *layered digital* devices that both captured *photospheres* (interactive panoramas) aligned with locations that were geolocated on Google Maps.

Layered digital devices were also used to engage in community-based scavenger hunts which were automatically posted to a social mapping app called *Siftr*. Photospheres were collected by youth which they could transform into *immersive digital* place encounters through the use of a special viewer like *Cardboard Camera.* A VR system (HTC Vive) loaded with Google Earth was setup beginning the third week so youth could take turns exploring the *immersive digital* neighborhood. These configurations are all represented on the CC (Figure 3).

WEEK ONE	WEEK TWO	WEEKS THREE & FOUR		WEEK FIVE
				
Daily Round Map	Capture the Neighborhood in Interactive Panoramas	Reimagine the Neighborhood in CoSpaces	Explore Home in Google Earth VR	Match Historical Perspectives in Google EarthVR
Paper, Pens	Smartphones w/ Google Street View App	Chromebooks w/ CoSpaces Accounts	HTC Vive + Google Earth VR	HTC Vive + Google Earth VR

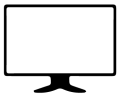
WEEK SIX	WEEK SEVEN	WEEK EIGHT	WEEK NINE	WEEK TEN
				
Neighborhood Siftr Scavenger Hunt	Create a Scavenger Hunt in CoSpaces	Build Objects for CoSpaces Worlds in Tiltbrush	CoSpaces & Google EarthVR	Showcase w/ a Collaborative Google Map
Smartphone w/SiftrApp	CoSpaces Chromebooks	HTC Vive + Tiltbrush & CoSpace Chromebooks	HTC Vive + Google Earth VR	Large Screen Connected to Google Maps

Figure 3. Technologies used in the ten-week postdigital PBE curriculum.

Materials

Throughout the ten weeks, we asked youth to build in VR with a web-based application called CoSpaces. With CoSpaces, youth could upload panoramic *photospheres* of the neighborhood using the

Google Street View app loaded on their mentor's smartphones (and occasionally their own). Participants could then digitally modify their photospheres within the CoSpaces builder. Youth were tasked to create 3D worlds that could then be accessed via a smartphone app and placed into a viewer like Google Cardboard (Figure 4), resulting in an immersive, VR-like experience. These digital artifacts became especially useful pieces of data to analyze because the build environment allowed youth to express themselves immersively and across analog/digital contexts in response to place-based learning activities. CoSpaces worlds along with Siftr served as the creative repository where youth could integrate aspects from place-based encounters into an environment that supported immersive engagement. Youth added each spatial encounter and scavenger hunt map onto a collaborative Google Map using a shared STUDIO account to collect and store each spatial encounter. Together, these three applications – Google Earth, CoSpaces and Siftr – provided the core infrastructure for youth to participate, learn through and contribute creatively to their place-based experiences. Left off of this list of applications is TiltBrush, a 3D painting app that youth used to create objects for their CoSpaces world. TiltBrush objects were effectively trapped in the world and unavailable for easy import into CoSpaces; however, the place-based object creation and interactions that youth interacted with were included for analysis.

Figure 4. Smartphone with Google Cardboard Camera viewer.

SIFTR & CoSpaces

Youth worked individually and in pairs with mentors on their CoSpaces worlds throughout the ten-week curriculum. Each CoSpace automatically created a QR code which youth then added onto their collaborative Google Map (Figure 6). Siftr provided a social mapping platform for youth to participate in a scavenger hunt of the neighborhood through image collection and sharing (Figure 5). Each activity, world, and student-generated path was added to a collaborative, neogeography-inspired (Turner, 2007; Elwood, 2013) map that served as a cartographic bridge between participants' analog and digital experience. Beginning the third week, a fully immersive HTC Vive Headset and handheld controls were available for youth to explore the neighborhood in Google Earth. Onlookers and mentors were provided with a desktop monitor connected to the VR system so they could observe and interact with VR participants (Figure 5).

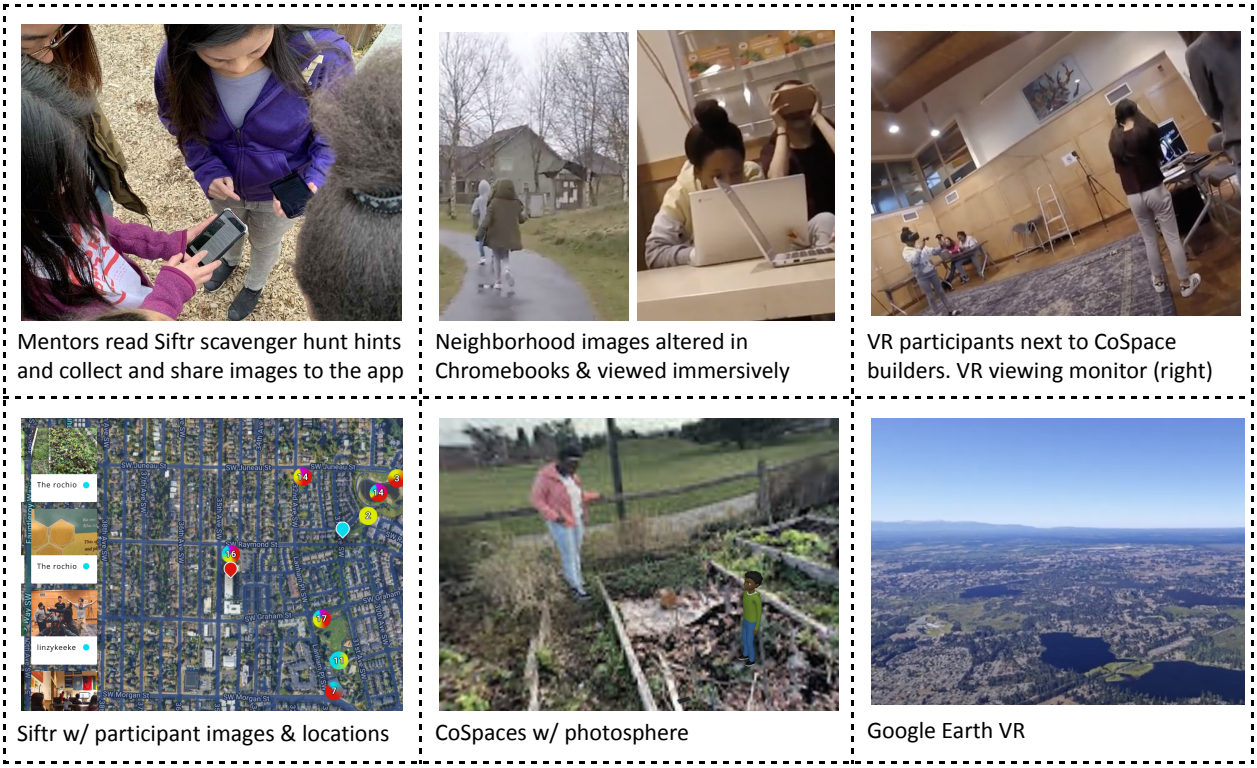


Figure 5: Technologies regularly used by youth as part of the postdigital PBE curriculum.

Data Collection

STUDIO undergraduate mentors assisted in recording observations of youth engagement during place-based learning activities. GoPro video captured learners' neighborhood movements and interactions. SIFTR, Google Maps, and CoSpaces captured interactive learner projects. A stationary camera captured VR participant movements, while screen recordings of the VR monitor captured participants' gazes, movements, and points of interest while they explored or created in *immersive digital* spaces via Google Earth VR. The microphone integrated into the HTC Vive headset recorded participants' speech. Although participants did not wear headphones, Google Earth VR provided haptic sound feedback to indicate when and where clicking occurred. Although participants could not hear clicks because they were not given headphones, clicks were useful indicators during analysis to indicate areas of interest. In addition, field notes, video content logs, and images were collected and coded according to place, and learners' spatiotechnical configurations. I coded interactions according to location using Google Earth Desktop Pro (Appendix A). Google Earth enabled me to keep track of material configurations of learners' interactions across spatial contexts; in other words, I could trace through areas of interest and note where on the analog/digital continuum youth had encountered them. To organize my data, I created a layer in Google Earth of each participant which I then contextualized by linking corresponding artifacts, videos and memos. Videos were content logged, transcribed and cross-linked according to location and participant for microanalysis. Each configuration was further sorted into a location along the analog/digital continuum.

Figure 6. Detail of the collaborative Google map shown with youth contributions. Icons represent the variety of additions included across the PBE curriculum.

Analytical Approach

With all participants mapped to a layer in Google Earth, I open-coded data (Strauss & Corbin, 1998) according to areas of interest and the material configurations (device and application) used by youth. Coding in this way led to an emphasis on visual representations and corresponding interactions that were further linked to corresponding analog encounters. Because I attended to the materiality of the digital and youth's interactions with it, visual representations and sensory engagement became the most dominant focus of analysis. Configurations of learners, devices and places were centered around collecting, sharing and remixing visual representations of analog encounters thus foregrounding the importance of visual interactions. Based upon the data collected, I was able to trace visual representations and interactions across material configurations.

The youth in the study engaged with Google Earth through visual representations that varied according to the material affordances of different configurations. These differences provided opportunities

for different kinds of interaction and engagement. For example, in Google Earth VR, the neighborhood pond became an area of interest because it helped youth navigate back to STUDIO, and subsequently home. Through analog-centered scavenger hunts, youth used digital devices as a different kind of representational assistance as they interacted with the analog pond. As I identified visual representations of locations of interest, I applied a visual ethnographic methodology (Pink, 2007) to examples that ran far along the analog/digital continuum; that is, representations could be traced from analog maps into immersive digital VR encounters. Upon identifying persistent representations, I used this as a guide to inform which interactions (Goodwin, 2017) to further analyze through youth's sensory place-engagement (Pink, 2015) which I describe in detail. This ethnographic method served as a pathway to consider the impact of material configurations on youth's place learning. By identifying visual representations along the continuum, I also consider the social, historical and spatial context of each representation and where they are cartographically situated. Cartographies are "technologies of power" (Massey, 2005, p. 107) and the "platforms, software and corporations with which digital maps are implicated imply one form of power" (Pink, 2012, p. 29). By considering the visual representations taken up by youth and then analyzing the configurations and interactions that contributed to their persistence, I was able to surface the impact of configurations on youth place engagement. As images persisted along the continuum, I identified visual similarities that were replicated across configurations, as well as differences that were intentionally or unintentionally rejected.

Autopoiesis and Liberation

I refer to the phenomena of replication as *autopoiesis* (Maturana & Varela, 1974; Luhmann, 1988). Autopoiesis originally referred to the ability of living organisms to continuously create and maintain themselves through interactions with the environment (Maturana & Varela, 1974). Luhmann (1988) applied the concept of autopoiesis to social systems as a way to describe how interdependent systems work to maintain boundaries integral to the system itself through communication practices. Applied to spatiotechnical systems, visual representations are the main method of communication. Persistence in

visual representations demonstrates autopoiesis in motion: the self-replication of the system through interactions. Because systems are not neutral, neither is autopoiesis due to the underlying systems of inequity that produce replication. By analyzing visual representations and their contextual interactions across CC configurations, I demonstrate how it becomes possible to see where power persists. In addition, as youth interact with places across configurations, they too are also able to identify oppressive visual elements representative of larger systems of marginalization which are then available for confrontation and digital or "glitch" *liberation* (Russell, 2020). Returning to Legacy Russell's *Glitch Feminism*, I identify moments in the data where youth identified opportunities within the digital environment to remix, hack and otherwise break free of its autopoietic, self-replicating visual aspects.

Summary of Findings

I was able to identify important places based upon the *persistence* of representations and then analyze youth's subsequent interactions with them. Through this method, I found two particularly persistent representations that traveled the entirety of the continuum (from fully analog to fully digital): Kay and Zee's representation of their home, and youth's interaction with the neighborhood pond. In the study, I follow Kay and Zee but touch upon their interactions with other STUDIO youth to demonstrate how spatiotechnical configurations were connected through persistent representations that replicated across different digital contexts. Kay and Zee's visual representation of home persisted yet subtle visual changes across configurations surfaced evidence of underlying hierarchies within spatial configurations. These changes were replicated across contexts through Kay and Zee, which I identify as an example of autopoiesis. In the second example, the pond becomes a focal point as well as an analog symbol of oppression as black youth are confronted by a white neighbor. I show how the pond is transformed into a digital site of liberation when the youth publish images of themselves defying restrictive neighborhood rules. Along the way, I show *where* on the CC these interactions unfold.

Kay & Zee's Home

CC Location: Analog

Kay and Zee were close friends and next-door neighbors who collaborated throughout the ten-week curriculum. Along with the larger group, the first task given to the youth was to map their "daily round" (e.g., Taylor, 2013) as a way to establish an initial baseline understanding of youth's place-based interests, methods of transportation, the places they regularly frequent, and daily interactions (Figure 6). Using colored markers and sheets of large paper, participants depicted the location of their house, and then spatially traced out their activities in relation to their home. To prepare youth for this activity, we first asked program participants to tell us about the places they regularly visited so we could document each location on a collaborative Google Map projected at the front of the classroom. This map served a number of purposes in this activity; for one, sharing locations from around the neighborhood in a large group often related to other frequently visited areas. Another reason this activity was useful was to ensure that a shared spatial representation of the neighborhood was presented in case some of the youth had never interacted with, or seen a map prior to the activity. In short, the collaborative mapping activity provided participants with a shared experience of the neighborhood; a "we-relationship" (Goodwin, 2018; Schutz, 1967) that collectively oriented and scaled the boundaries of the neighborhood from which youth could draw upon. The Google Map projected onto the wall of the large meeting space provided a "window-into-place" – a *digital analog* window that helped youth locate their place-based experiences.

Figure 7. Visual representations of home produced across the cartographic continuum.

Kay and Zee's paper map is unlike the others' in this study as they did not draw it (Figure 7) from a standard map-like overhead view, as would reflect the orientation of the collaborative map (Figure 6). Rather, the next-door neighbors chose to draw their homes from a ground-level view in a forced-perspective and three-dimensional style (Figure 6) indicating a less-abstract orientation to thinking about the orientation of their home within the neighborhood Throughout the drawing session, Kay led the creative effort while Zee enthusiastically checked Kay's progress, exclaiming at one point that she wanted to make sure their drawings match (Zee's map image is very similar to Kay's, but not included because of the poor quality of its capture). Rather than emphasize the distance, or borrow from typical mapping language, Kay emphasized her home's likeness and proximity to Zee's (Figure 7, lower left). Footsteps emphasized the activities the girls routinely did together: walking to each other's house, and walking to

the grocery store. This visual representation marks where the girls' representation of home started from: an analog paper map that emphasized walking, trees and their pet cat all depicted from their point of view.

CC Location: Immersive digital

During their building process, Kay and Zee had the opportunity to spend a few minutes exploring their neighborhood in Google Earth VR. This immersive digital experience appeared to greatly impact Kay's feelings toward her home, effectively showing her a version of the neighborhood she had never encountered before. The journey was jointly observed by mentors, researchers, and friends who gathered around the VR monitor where they could watch both her analog and digital movements. In the excerpted transcript below, Kay has just encountered her virtual neighborhood for the first time. She has spent her first few minutes "flying" around when she recognizes the neighborhood pond and realizes that she can follow it to her house. As she lowers herself closer to the ground, the details of the digital neighborhood come into view.

(E)rin and (D)on are researcher/facilitators. (R)ae is (K)ay's mentor.

1. K: This is so cute! Oh my god, I'm literally about to cry! (*sighs then gasps*)
2. Look at these little trees! (*gets down on hands and knees*)
3. Oh my god, I could literally touch – It's like a Barbie house! (*sits all the way down on the floor*)
    a. [Onlookers laugh]
    b. R: Go into the tree and see what happens!
4. K: (*leans face into virtual trees, then gasps as the rendered planes of the trees give way to abstract shapes typical of traveling "out-of-bounds" in 3D environments*)
5. I can see the underworld! Yeah I'm gonna walk to my house.

As Kay explores the simulated world, the sense of scale remains skewed, and she is positioned over the trees. Her relationship to the rendered digital world is unlike anything she has ever experienced in her analog life, and so she calls upon memories of interacting with houses that resemble her current experience thereby enacting autopoiesis through cultural representation. Looking down at the cartoon-like

rendering of her home, she calls it a "Barbie house," and describes the trees as "little." Google Earth's rendered neighborhood reads differently from her previous aerial VR experience and so she begins to call upon visual representations to make sense of her interactions. Where initially she entered the digital environment high above the city in aerial "superman" mode, she soon finds herself on her hands and knees "playing house, " thus replicating childhood systems of play reinforced through pop culture icons like *Barbie*.

Throughout her digital neighborhood exploration, she maintained an awareness – a connection – with the people simultaneously watching her in analog and *digital analog* space despite her inability to see them. As observers, we were in constant dialogue with her throughout her immersive digital journey.

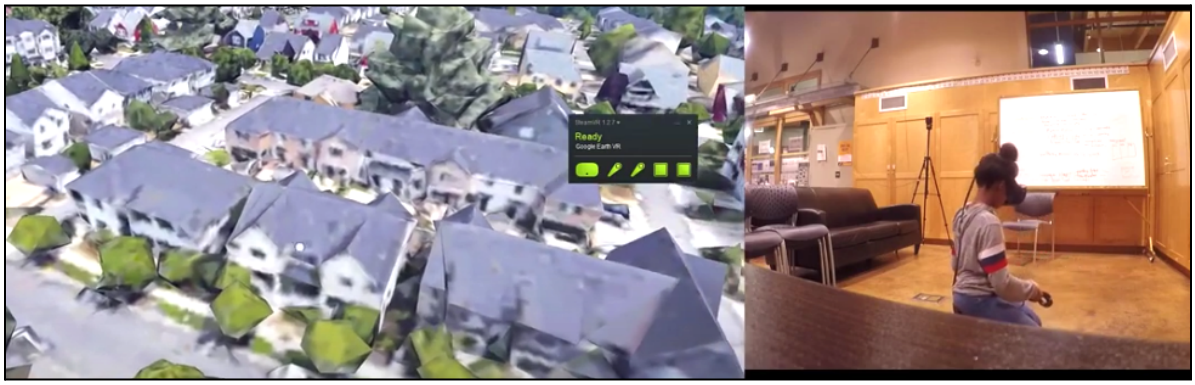


Figure 8. Kay (right) explores her home (left) in Google Earth VR.

Sitting down so she can get closer to her digital neighborhood, Kay improvises a way to move without getting up from her position (3).

6. K: (*moves controllers in a running motion to move along virtual street*s)
   D: Oh is that how you move?!
7. K: Yeah. I'm so lost… Where's my house?

After a bit of searching, Kay turns and sees her house.

8. K: (*Gasps*) This is my house! (Figure 8)
   All together: Oohhh!!
9. K: I'm right here (*leans down and points with the controller*) and that one's Zee's.
   D: Touch your home, touch your home!
10. K: Oh my gosh! (*moves legs so she can sit cross-legged, then leans over her house and begins to try to hold and interact with it through her controllers*)

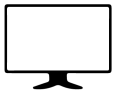
[Rae and Don begin to laugh loudly]
R: Touch the roof! Touch the roof!
D: Raise the roof! Raise the roof!

11. K: (Oh my god my little baby brother was at the window right there and he was like screaming for my name…(*gasps and holds photo sphere control up to face and looks in it to see a photograph of her street and house)* Oh what the heck! This was my house... right here you can't even see it, it's so blurry.
D: Alright take one last little…
R: Say goodbye.
12. K: *(points with the controller)* That's my mom's car right there! (points with
R: That's your mom's car?
D: Say goodbye to your mom's car.
13. K: Oh wait, I just gotta.. *(turns to a tree, leans over and makes a hugging gesture, then a kissing noise).*
R: Hug that tree!

Kay's enthusiasm for her digital home is rooted in her analog memories as she points to recognizable items rendered in Google Earth. She finds their visual simplicity moving as she is positioned as a giant looking down upon a cartoon representation of her neighborhood. She does not reject this version of her home as inaccurate, rather she claims ownership over her digital neighborhood (*my* house and *my* mom's car at turn 7) and sits closer as if trying to go into her house and maybe see her brother (turn 8), despite the absence of rendered people. Kay takes on this miniaturized view and incorporates it into her representation of home: portable, miniaturized and huggable. Kay's interactions point to the underlying discourse at play: a cartoon-like representation of home where houses and neighborhood features can be interacted with like toys. This abstraction is then autopoietically replicated by Kay both interactionally (as she tries to "raise the roof") and relationally (as she tries to hug and kiss the tree rendered outside her front door (turn 10)), the same tree she depicts in her analog map.

From this extreme, opposite point along the CC, the relationship between analog and digital is beginning to take form. The material qualities of the immersive digital place encounter offered by Google Earth project a playful, childlike quality to the environment that Kay is quite taken with thus establishing a visual geography that is playful and imaginative as she pretends to see her baby brother in the window (11).

Figure 9. Kay looks downward to her home, and points out her mom's car. "That's my mom's car!" Kay exclaims, and then looks to the next car.



CC Location: Digital Analog

In the following weeks, Kay and Zee were tasked with collaboratively representing their daily lives in CoSpaces, a VR environment builder designed for young people. The VR building process took place on the *digital analog* configuration of the CC, but could also be experienced immersively. CoSpaces was designed to cross boundaries between handheld devices, desktop computers and VR viewers; for that reason, it served as a perfect creative tool to trace along the CC and to analyze how and where young people engaged with it along the continuum. Kay and Zee spent most of their CoSpaces time building their *immersive digital* neighborhood through a "window-into-place" via a single computer screen despite two being available. The collaborative process echoed their analog mapmaking experience from the beginning of the curriculum. Sitting side-by-side, the duo worked diligently in CoSpaces over a single screen to recreate their side-by-side houses, taking turns at the keyboard in between creative discussions. As they worked, the girls would take turns viewing their creations *immersively* on their phone with a Google Cardboard viewer, and then returning to editing their work on the Chromebook's *digital analog* screen (Figure 10). Looking through the viewer, the girls would look left and right and only glance at the scene behind them despite the availability of a full 360º view. The CoSpaces connection between the screen and the viewing app enabled Kay and Zee to work across digital boundaries, yet their focus

remained within the confines of the screen frame and they worked to compose the scene accordingly, reflecting their tendency to replicate visual compositions they had previously seen of Google Earth framed through the VR headset. This subtle example of autopoiesis in motion demonstrates how the material agency of the digital environment informs how representations are taken up and replicated across contexts.

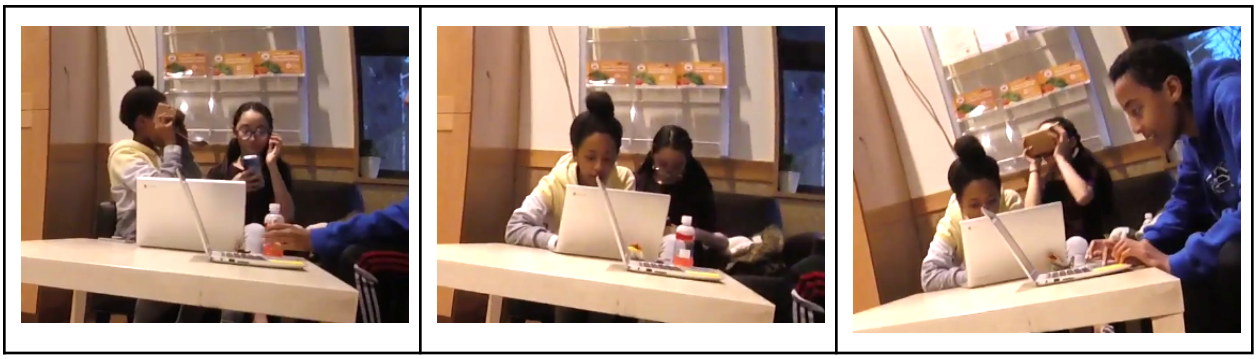


Figure 10. Kay and Zee take turns examining their CoSpaces world in the immersive digital viewer.

CC Location: Immersive digital

Sociospatial resources

Kay and Zee's arrangement of their CoSpaces' homes demonstrated the autopoietic agency of digital boundaries. Kay's analog paper map (Figure 6) included footsteps and excluded cars. After exploring their *immersive digital* homes in Google Earth VR, Kay and Zee returned to CoSpaces and added models of their parents' cars in a near-identical pattern to their vehicles depicted in Google Earth (Figure 6). In addition, the girls added trees and avatars of themselves in CoSpaces – additions not included in their analog maps. The CoSpace object library made it possible for the girls to closely create a version of their home as depicted in Google Earth. The CoSpaces object library also included creative aspects not encountered in Google Earth. For example, the girls added a rainbow and animations of themselves dancing in unison (Figure 11). Although some objects could be created and imported, time constraints and usability issues restricted the girls' creative decisions to those offered by CoSpaces. While some additions

were creative, others were less empowering. For example, Kay noticed Zee's avatar and asked if CoSpaces provided an Asian model. Zee shook her head and Kay mumbled "racist." Zee shrugged as if unsurprised by the lack of representation available to her across sociospatial configurations. Here is an example of a spatial system built upon limited racial representations that are then autopoietically replicated by default. The result is a mismatch between Zee's represented race and her actual race. In *Glitch Feminism*, Legacy Russell emphasizes the importance of the avatar as a way to transcend the confines and limitations of the body; ultimately, an avatar is about freedom. Zee wanted to represent herself, her race through her avatar alongside Kay; yet, she was not given the choice via the material resources of the digital environment thus demonstrating its underlying agency.

Figure 11. Kay and Zee include their family's cars in their CoSpaces scenes.

The Pond

A centerpoint of the postdigital PBE curriculum was the local pond. Located a few blocks from the community center, the pond became a focal point for engagement as youth included the feature in their scavenger hunts and image collections. The pond came to represent the identity of the neighborhood and as such became a rich point of postdigital study. During our first group encounter with the pond, undergraduate mentors were asked to install Siftr, a social mapping app that I used as a scavenger hunt hint provider and image collector. Mentors provided access to the maps while youth tried to solve the hints, many of which involved the pond during the first scavenger hunt. Although not a designated play

area of the Hope VI mixed-use neighborhood, we knew that the pond was a favorite area for youth – mostly black, and all children of color – to walk around and play as they always suggested featuring it in their outdoor place-based encounters.

Figure 12. The pond across the cartographic continuum.

During the first scavenger hunt, one youth, Yousie climbed down onto the pond rocks only to be quickly reprimanded by a middle-age white man walking his dog. "The sign says *don't climb on the rocks!*" the man yelled. Startled, Yousie stopped, looked up, and yelled "sorry!" The man then shook his head, "Just sayin'." After the man was out of sight, a STUDIO researcher and several scavenger hunt

groups climbed up on the rocks and posed for a picture in front of the sign reading: *Do not enter; no playing or walking around the waterfall or rocks.* As part of the scavenger hunt, several mentors captured photospheres of the day and posted images onto Siftr (Figure 12c).

Location: Layered Digital to Immersive Digital

In the following weeks, Kay and Zee spent the majority of their time collaborating over a shared computer screen that served as a *digital analog* "window-into-place." As a final outing, youth were asked to take their mentors on a tour of their favorite area in the neighborhood. While all groups were given GoPro cameras to document outings, Kay and Zee in particular loved to be in front of the camera and took their mentors to the pond. The weather on this day was particularly wet and rainy, and so the girls reminisced about sunnier days. One mentor, Rae, asked them to tell someone who had never been to the pond why they should come as part.

Figure 13. Zee and Kay discuss the pond.

(R)ae and (T)i are (K)ay and (Z)ee's mentors.

1. K: Umm…it's really pretty when it's sunny
   Z: *Only* when it's sunny [bends over laughing]
2. T: So I'm guessing you are you guys… are a fan of the sun better than the rain?

K & Z: Yes…
T: Why's that?

3. K: Cause' just like, rain is just like, kinda depressing to me, y'know?
4. T: Hmm [agreement]...if it was sunny and raining at the same time, is that the same thing?
5. Z: [gasps and turns to K] That will cause rainbows!
6. K: Yeah… which is way better.
7. T: Okay… what do you call…the weather when it's raining and sunny at the same time? [pause]
8. K: Runny.
9. Z: [turns to Kay] What!?!
   [laughter]
10. T: You know what I call it?
11. Z: No! Seattle!
    T: You know what I call it?
    K: Hmm?
12. T: A sunshower.
13. K: Oooh. I like that. That's cute.

It is clear that the girls would not be outside at the pond if they did not have to be. They are both cold and thinking of sunnier days because rain is "kinda depressing" (3). Aside from the presence of the camera, they are having a completely analog experience on an early spring day in the pacific northwest, but as they continue to walk along the pathway, they regularly note the ducks and how much they appreciate their ongoing presence at the pond. Rae stops to take a photosphere and then asks the girls about their interest in the ducks.

R: Can you tell us about your past interactions with the Ducks?
Z: Um…
K: Uh…
Z: [turns to Kay] We almost killed one.
K: [turns towards the camera] Yeah..
Z: [giggling]
T: How?
Z: Feeding it diabetes…
K: Oh yeah we were bringing like Cheerios and like other sugared stuff…which we looked up [gesturing as if looking it up on her phone] if we could and it was like *no!* And we were like whaaa?

While the girls did not have their phones with them during the walk, information they gained while engaged with a *layered digital* configuration of the pond stayed with them. Back in the lab, the girls uploaded their photosphere and added in a rainbow and birds in thought, reflecting their analog outing.

Collecting images in the analog environment was an integral part of the postdigital PBE curriculum. Using mentors' smartphones, youth could collaborate over the digital devices to collect visual place-based resources to use in their collaborative projects. Towards the end of the curriculum, a youth was walking around in Google Earth VR and managed to "step" into a panorama that Kay and Zee took for CoSpaces. To our collective surprise, Google Earth had published the photosphere, along with a few others, into their cartographic infrastructure. We discovered this when another youth was watching the VR screen from the sidelines, and noticed himself on the *analog digital* screen, rendered into the digital virtual world. "Hey, that's me!" he exclaimed (Figure 13). Inadvertently, mentors had published geolocated panoramic images of youth that appeared in Google Maps, Google Street View, Google Earth, and Google Earth VR. While youth were excited to see themselves rendered into the digital world, privacy concerns compelled us to delete the images. The underlying agency of Google Street View simultaneously provided the material resources that enabled youth's liberation from the oppressive pond rules, while also enacting its own agency to use their imagery to produce Google's cartographic infrastructure. In this example of autopoiesis, the location-aware networked infrastructure violated the privacy of minors by identifying where on earth they were and then resourced that information to maintain ongoing visual fidelity of the environment. Although Google now automatically blurs facial images, the underlying agency of its cartographic tools represents the tension between autopoietic self-replicating systems and possibilities for young people to confront, resist and challenge them through their own material resources.

Figure 14. Hey, that's me!

Summary: Seeing Autopoiesis through the CC

In this example of what a postdigital PBE curriculum might look like, the CC highlights how Kay and Zee made use of the sociospatial resources to which they were given access. When compared to the analog resources they began with, the agency of different digital configurations begins to emerge. In the process of recreating a scene from their day-to-day life, the *immersive digital* Google Earth becomes the authority and so the girls overwrite their pedestrian-centered digital home with the addition of their parents' cars rendered in exactly the same orientation as they encounter it in VR. As an example of *autopoiesis*, the digital environment of Google Earth asserts boundaries that render cars visible, while people are rendered invisible. Kay and Zee include their parents' cars as part of their representation of home and include additional trees while rejecting the absence of people by including themselves. However, they are limited by the CoSpaces library, and Zee is forced to adopt a white rather than Asian youth to represent her in her own *immersive digital* rendition of home. Conversely, the *immersive digital* environment became an avenue of *glitch liberation* (Russell, 2020) from analog realities: youth were able to fly through Google Earth VR, and publish themselves into the digital world rendering themselves visible in a way that the rules of their Hope VI housing environment discourage. The CC shows the agentic importance of the sociomaterial environment as an integral aspect of PBE in the digital age.

Discussion

In this study, PBE is framed as a *postdigital* pedagogy where youth interactions with the analog/digital environment highlight the need for new cartographic methods of data collection and analysis that address the emergent complexity of place learning. I positioned the CC as a method to *think through* place-based learning as well as to begin to analyze the sociospatial affordances of devices. The avenues of access we have to place and space are not neutral, and by looking at place-based representations through the CC, I showed how certain representations were elevated and replicated. Although the examples depicted here may seem somewhat benign, the CC highlighted the autopoietic aspects of sociospatial systems that repeat, and can be repeated in the analog world. These examples show how distinctions between analog and digital spaces are built upon faulty assumptions that places are made up of one or the other extreme. I argue that underlying power structures are reincorporated into digital geographies and are easily taken up and replicated through everyday interactions. I advocate for a postdigital theory of place-based education that includes authentic digital place-based practices as a pathway towards confronting the underlying self-replicating systems that reinforce inequity.

In the case of Kay, she was able to interact with her peopleless home as if it were a dollhouse. Abstracted in this way, digital geographies offer a playful and affective representation of place that obscures underlying constraints. Google Earth emphasized cars and trees and so those representations showed up in Kay and Zee's representations within the *immersive digital* through CoSpaces. While this curriculum demonstrates novelty, it also demonstrates possibility between place learning through emergent technologies like Google Earth VR, and place production.

Although youth did not intend to publish to Google Earth, they unlocked future possibilities by "walking" into themselves in VR. Published to Google Earth across platforms, the youth in this study excitedly discovered that they could write themselves *into* the digital rather than be completely informed by it. While this was a privacy nightmare for the educators and researchers running the curriculum, for youth they were given the opportunity to claim their home through unique and creative expression. Contrasted to their analog adventures, youth were given a set of rules reinforced by the asymmetrical

limitations of age, race and economic power dynamics of the neighborhood. In VR, youth could fly and they responded to this freedom by engaging in *glitch liberation* – the creation of identity spaces that represented themselves, their interests and their power. Of this kind of digital innovating or "remixing,"Legacy Russell (2020) writes:

> We are faced with the reality that we will never be given the keys to a utopia architected by hegemony. Instead, we have been tasked with building the world(s) we want to live in, a most difficult yet most urgent blueprint to realize. If we see culture, society, and by extension, gender as material to remix, we can acknowledge these things as 'original recordings' that were not created to liberate us. Still they are materials that can be reclaimed, rearranged, repurposed, and rebirthed toward an emancipatory enterprise, creating new 'records' through radical action. Remixing is an act of self-determination; it is a technology of survival. (p. 133)

The materiality of the digital environment represents a kind of survival: across the material boundaries of the CC we saw which representations and place-based practices of home held, which could be contradicted, and which ones would break down. I call this *autopoiesis* intentionally because the digital environment is able to co-opt learners into this process of survival. Enamored by seeing her mother's car in the *immersive digital* VR neighborhood, Kay replicated the vehicle-centered model into her substrate of home, overwriting her previous pedestrian-centered model. Through an autopoietic lens, the car-centric model of her neighborhood is trying to survive through her, yet she is likely unaware. My advocacy of engaging in postdigital PBE is aligned with a key precept of critical PBE: to *critically* learn through place. The CC makes visible the visual representations that youth engaged with across various spatiotechnical configurations (smartphone, VR, Google Earths) of space as they transformed them into place. It is when youth are co-opted into replicating inequities thereby reinscribing them into the digital environment that little opportunity for remixing and self-determination remains.

Implications for the Future of Learning

Little has been written about the *Metaverse*; however, the youth in this study begin to address some of the underlying issues of PBE that a postdigital approach can begin to address. The tension between autopoiesis and liberation mirrors the tension between identity and security. Autopoiesis wants to reinforce existing systems of bias and inequality that often reinforce identity narratives. The representations that youth drew upon are built upon data that has been "recolonized" (Couldry, 2019) by platforms leveraging human resources into place-based material resources. The implications of colonizing data are beyond the scope of this methods proposal, yet the ideologies that are distributed threaten future rights to places across analog and digital contexts. The *Metaverse* is one area of many where we are seeing this process unfold. It is notable in its relationship to physical space: corporations have staked out digital land holdings. However, applied to existing infrastructures, platforms that amplify and reify analog bias like Nextdoor, Facebook (Meta), and Trulia's crime heat map (recently removed due to bias complaints) demonstrate the already existing need for a tool like the CC to highlight the complex relationship between the analog and digital. It cannot be overstated how flexible the boundaries of the CC should remain as space and place continue to be reconfigured into the Metaverse and beyond.

PAPER TWO: **TOWARDS HISTORICALLY EFFECTED CONSCIOUSNESS**

Abstract

What would a critical pedagogy of a local place look like in the post-digital (Jandrić, 2018) age? This study investigates a curriculum of place that aims to de-settle local narratives by incorporating mundane and emergent spatial technologies alongside a series of analog, digital and curated encounters of a single place. Through a dialectic of place perspectives, the familiar is made strange (Bell et al., 2019) through a series of spatial encounters. Students begin the curriculum with an in-person visit of a historically infamous, yet little understood area of the city, and then revisit it virtually in Google Earth VR. In this study, undergraduate students confront multiple yet contradictory encounters of the same river. Augmented and virtual technologies are interwoven throughout the curriculum to support postdigital inquiry around place and placemaking. Student reflections, artifacts, video and images were analyzed for "claiming moments" indicating that students were surprised and had experienced interpretive distance – an incongruence between what they knew and thought they knew. Findings from the curriculum design revealed evidence of critical inquiry, reflection and engagement.

Introduction

Place is always changing, becoming more virtual and difficult to define (Cresswell, 2015). In the digital age, its complexity is rapidly "increasing uncertainty about what we mean by 'places' and how we relate to them. How...can we retain any sense of a local place and its particularity?" (Massey, 1997, p. 315). Geolocative mobile technologies and social media have only made these questions more relevant (Taylor, 2013; Taylor, 2019) as emergent uses of locative applications and devices increasingly redefine spatial boundaries across "dynamically changing socio-cultural spaces" (Leander et al, 2010). Ephemeral,

constantly shifting digital geographies reflect the ephemerality of emergent place construction. Massey asks how it is possible to make new connections without temporality, without historical context (2005).

Massey's questions reflect the need for more research and inquiry around new possibilities for learning and participation in place and community through common, everyday place engagement. Spatial technologies transform the dialogue between the physical and digital, and open up new opportunities to connect "little narratives" of self to "big narratives" of place (Rowe, et al, 2002). Mobile devices inform spatial engagement and inquiry, and are commonly used to layer meaning upon the lived environment (Sakr et al., 2019) through smartphones, while immersive 3D simulations of place make it possible to visit virtual representations of the lived environment. At the same time, spatial technologies are built upon underlying algorithmic biases (Jefferson, 2020) that risk reinforcing dominant narratives, and in doing so, settle assumptions about places and the people that make them. The digital is built upon foundational collective narratives that reflect larger "geographical imaginaries" (Said, 1979; Gregory, 1995; Massey, 2007), "...an implicit geography that organises our social understandings, that supports – though usually without being mentioned explicitly at all – the analyses in documents (as well as practices) of all kinds" (Massey, 2007, section 2, para 3). In this study, I explore how emergent and mundane spatial technologies can support learners in "challenging the assumptions, practices and outcomes taken for granted in dominant culture" (Greenwood, 2003, p.3)?

Place-based education and digital engagement

Current mobility research in the learning sciences (Leander et al, 2010; Taylor, 2017; Shapiro, 2018) support Massey's proclamation that place is about "routes not roots" (Massey, 1994; Creswell, 2004). She argues such connection-based changes are an offshoot of rapid globalization (Cresswell, 2004; Massey, 1994), an argument which stands in direct opposition to Greenwood's recommendation to limit technology's use in critical place-based education (Greenwood, 2007). He argues that technology "...limits, devalues, and distorts local geographical experience" (2007, p. 8). Yet such mandates overlook opportunities to link sociotechnical representations of place with dominant narratives and lived

experience (Taylor & Hall, 2013; Taylor, 2018). In addition, excluding spatial technologies from place learning and engagement risk reinforcing powered assumptions of place reinforced through the assumed authority of digital geographies. Physical and virtual conceptions of place are "...[A] shared resource...and when you give all that power to a single entity, you are giving them the power not only to tell you about your location, but to shape it" (Wroclawski, 2014 as cited by Cresswell, 2015, p.4). In response, I designed a critical pedagogy of place centered around de-settling assumptions of local community and place histories. Through a series of digital, analog and curated place encounters, I incorporated spatial technologies (all Google-based), not to use as an end in itself, but as a pathway towards multiplicity (Massey, 2005). By incorporating mundane and emergent spatial technologies into place-based learning practices, I posited that through the complexity of multiple place encounters, young learners would more readily open to moments of epiphany and surprise thereby surfacing and desettling underlying biases that reinforced dominant narratives.

Theoretical Framework

The structure of this curricular design study is based upon a *postdigital* learning framework (Jandrić, 2018), where mundane uses of technology are positioned as normative, authentic and integrated. A postdigital framework assumes learners are members of sociotechnical assemblages (Latour, 2005; Star, 1999) who enable new methods of collaboration, creation and its associated skills (information seeking, location awareness, image gathering) to make sense of the world around them. Rather than privileging technology over human labor, or extricating it from the curriculum altogether, a postdigital framework considers technology to be part of the world and not separate from it. Through this approach to education, relevant technology use is integrated into the curriculum rather than being artificially excluded from it. Applied to place-based education (PBE), spatial technologies and digital geographies are incorporated into the learning process.

Heterogeneity

A key aspect of postdigital learning and engagement is *heterogeneity* (Macgilchrist, 2021) – diverse opportunities to engage with a variety of stories and perspectives, reflective of the complexity of the Internet itself. When locations of learning are stretched beyond the classroom, young people carrying cell phones are positioned as connected members of sociotechnical assemblages (Latour, 1999), yet PBE literature largely ignores this fact (Greenwood, 2015). Similarly, education research that seeks to learn about learning through technology often emphasizes the efficacy of specific technologies rather than examining the uses and technology practices embedded into the learning environment (Leander et al., 2016; Hayles, 2014, Knox, 2019). To fully engage in a critical pedagogy of place, I argue it is necessary to address the underlying power dynamics that create places which include digital geographies connected via portable connected location-aware devices that people use to co-constitute place. The curriculum I propose is concerned with learners who are of the place in question – a shared context. Place perspectives assume deeply entrenched personal experience of place that has played a key role in the formation of identity (Holland, 1998). To enter a new perspective of place is to enter into dialogue with other perspectives that have shaped the learner's sense of self. Every place has a complex history steeped in geographical imaginaries. Not every story is told and not every story has a chance to be heard; rather, "official" histories are relayed through mythologies and reinscribed as doctrine into classroom textbooks (Williamson, 2006; Goldberg et al., 2006).

Towards historically effected conscious

The curriculum I present attempts to confront single-story narratives through multiple place encounters as a pathway towards desettling colonial place-based narratives that unwittingly seep into the local fibers of a place and the people living in those places. Through these place encounters, I aimed to situate the learner in place, history and time to reinforce how we are all implicated in our own place histories; we are not separate from history, we are of history. To reach this kind of understanding is to achieve what Hans Gadamer (2013) calls *historically-effected consciousness* (HEC). Gadamer theorized that this kind of

understanding happened only when one is forced to surrender fundamental assumptions about self and the world – changes that only came under the weight of new knowledge. Gadamer argues that in order for such a shift to occur in the consciousness of a person, they must "...place in the open. As against the fixity of opinions, questioning makes the object and all its possibilities fluid" (Gadamer, 2013, p. 376). In other words, it is in the breaking down of assumptions that it becomes possible to open to other perspectives. I drew upon Gadamer's theory of HEC and his philosophy of openness as a philosophy from which to engage learners with place. Throughout this study, I drew upon the components of HEC which I explain further as a way to make sense of the dialectic that I observed learners enter as they encountered contrasting place perspectives.

The kind of complexity and ambiguity that postdigital learning offers stands in stark comparison to content learning and assessment. Educators can often assume a level of simple content knowledge that includes names and dates; however, the context of places is far more complex. Histories are nuanced; insiders have far different perspectives than outsiders; insiders have different daily rounds largely structured by inequitable access to resources. To that end, HEC is only possible through open dialogue between two *horizons* of understanding (Gadamer, 2013), absent of an end goal. This philosophy can be seen in scholars like Dewey who famously wrote that entry into a subject should be as "unscholastic as possible" and that the best education gives "the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results" (Dewey, 1916, p. 118). HEC also resonates with Biesta's curriculum of emancipation from oppressive colonial thinking (Biesta, 2013); not to teach a subject, but to teach the "indispensable" (Biesta, 2017).

Conceptual Framework

I sought to engage young people in multiple place encounters – analog and digital – in order to cultivate uncertainty, elicit inquiry, foster critical thinking and confront assumptions and biases. In this design, I positioned the environment as the teacher and embraced Donna Haraway's claim that "[t]here is no view

from nowhere" (Haraway, 1988) as an essential design philosophy and embraced the multiple stories that emerged through place encounters thus opening opportunities for youth to draw connections to cultural practices across settings (Sandoval & Shea, 2020; Stromholt & Bell, 2014). PBE often relies upon the people who live in places to elicit critical inquiry; yet, often residents themselves are complicit in their own limited narratives. The question I was challenged with was how to design a curriculum that confronts underlying biases to "challenge the hegemony of dominant narratives and help to create spaces for marginalized perspectives and histories" (Elwood, 2006, p.11) when dominant narratives are often unintentionally reinscribed (Elwood, 2005)?

Designing for interpretive distance

A critical concern of this curriculum is to confront local learners to desettle underlying biases reinforced through local geographic imaginaries. I wanted young learners to begin to question what they knew and how they knew it. This process, according to Hans Gadamer, cannot be planned for; rather, it is through dialogical encounter with "what is at once alien to us, makes a claim upon us, and has an affinity with what we are that we can open ourselves to risking and testing our prejudices" (Bernstein, 1983, p. 129). With this in mind, I set out to engage learners in a series of place encounters that would elicit *interpretive distance* (Gadamer, 2013), or comparisons separated by time or mode of engagement. Gadamer theorizes that interpretive distance is the precursor to HEC; that HEC can only be achieved through encountering situations that are familiar enough to be recognizable, but different enough to address underlying assumptions that block the person from true understanding. In essence, interpretive distance does just this. According to Gadamer, understanding comes through encounters with places, events and conversations that "claim" us beyond "our wanting and doing" (Gadamer, 2013, p. X). It is only when we are caught by surprise, willingly ready to admit that we did not know what we did not know, that HEC is possible. In that moment, we realize that we are subject to the same biases and assumptions that dominate cultural narratives and reflect the rhetoric of our time; we realize that we are products of our environment and are subject to the same harmful narratives and biases as anyone else. I call these moments "claiming

moments" and identify them according to indications of awe or surprise. Statements like "I never knew…" and "I cannot believe" indicate that an encounter with a place had claimed the learner – had caught them by surprise. Claiming moments indicate interpretive distance on behalf of the learner, a precursor to HEC. If HEC occurs, "the horizon of understanding" (Gadamer, 2013, p. X) is fused with a higher horizon of understanding. To design for this level of epiphany, is to design for HEC – neither of which are possible as we cannot force a person to release biases they do not know they have. However, it is possible to design for interpretive distance, as it requires heterogeneous comparisons of similar things.

In this curriculum design study, I posit that horizons are made up of geographical imaginaries and learned experiences that form underlying assumptions – or what Gadamer refers to as *prejudices* (2013). These states of knowing can be alternately fluid or rigid depending on the readiness of the learner to question his horizon. HEC can only occur when a "fusion of horizons" (Gadamer, 2013) takes place (Figure 1); that is, when previous foundational assumptions are broken down and replaced with new knowledge.

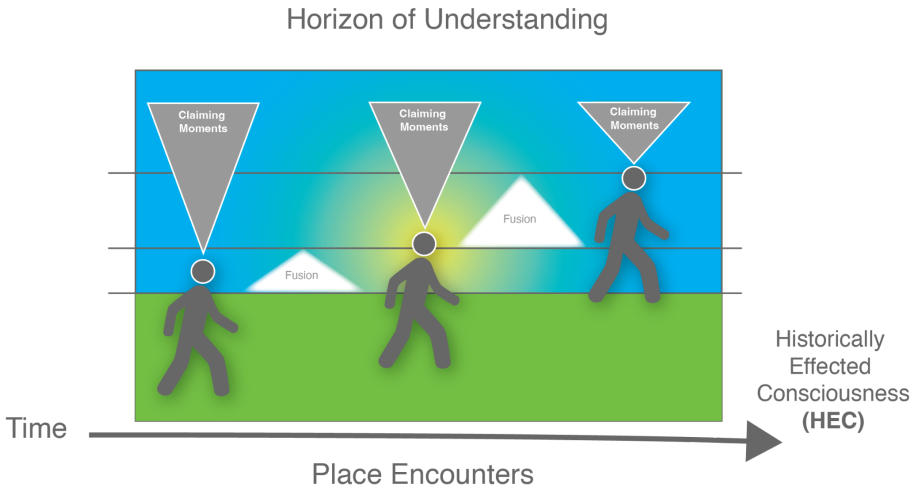


Figure 1. Claiming moments elicit interpretive distance which raises the horizon of understanding and contribute to HEC.

Eliciting Interpretive Distance

I theorized that by engaging young people in multiple encounters of the Duwamish River, a local and significant waterway named for its original tribal inhabitants, that comparisons between encounters (and through the learners' prior knowledge) would elicit contradictions that learners would have to confront. When that happened, the learner would convey surprise became they were "claimed" by an experience above their "wanting and doing" (Gadamer, 2004, p. 305). I identified exclamations such as "I didn't know that!" or "wow!" to indicate that interpretive distance had occurred, and HEC was possible. Although I could not adequately determine if HEC had occurred, it served as a goal post to aim for in my research.

Through this proposed postdigital curriculum of place I asked:

> *1. When virtual and lived perspectives of place are placed into dialogue with one another, what contentions, hypocrisies, and false assumptions claimed learners that they were then forced to examine?*
>
> *2. What kinds of questions did learners surface in that examination?*
>
> *3. How were learners incorporating spatiotemporal technologies in the sensemaking process? What conclusions did they come to?*

Methods

Curriculum Design: Postdigital Dialogues

Data from this study come from 18 students participating in an informal education class offered at a large public University over two quarters. Participants in each quarter were taken on six different *place encounters* of the Duwamish River in Seattle. I focus on the first three encounters to highlight the relationship between the lived (via walking along the banks in a park), curated (via a cultural center next

to the river), and digital (via Google Earth VR) Duwamish River. Conducted over two quarters, each encounter represented a perspective of the River. These included 1) Herring's Park, a historically significant park along the River; 2) The Duwamish Longhouse and Cultural Center, a museum and longhouse built and curated by the Duwamish people, and 3) a Google Earth VR walk along the Duwamish River. I accompanied undergraduate students to each location and recorded their interactions using GoPro video cameras. After each encounter, I collected assigned student reflections which I cataloged along with video data that I included in reflective memos that I explain in detail below.

Participants

I served as a graduate mentor to two groups of 8 and 10 undergraduate students as part of an innovative informal education class designed to engage with theories of learning in out-of-classroom contexts (see Bell, 2021). Students were second or third-year students majoring in an education program that is demographically diverse and majority female within a large public university. Of the 18 consented participants in this study, one identified as a white male. As a graduate mentor and participant researcher, I chose and planned the logistics around each place encounter, as well as the order. My explicit role as a mentor was to connect theories of learning to place; however, participants were under no pressure to learn the specifics of the places we visited. Learners were not explicitly directed to make connections to self or history outside of sociocultural learning contexts to allow space for questions to arise organically. I focus on data from six students (three from the first group and three from the second) whose interactions and observations represent larger thematic findings of the curriculum design: interpretive distance elicited critical questions surrounding power, history and authority. Although I analyze these two groups together, their different backgrounds elicited insights specific to each group that notably led to similar conclusions. Participants were education majors local to the region. Their demographic information comes from information gleaned from written reflections and recorded conversations. From the first group they are: Neil, a white male who spoke often of his participation in a conservative Christian group on campus; Mia, a Latina woman who spoke often of her mother's immigrant background; and Ali, an Asian woman

who was dual majoring in economics and often the first in the group to notice power inequalities. From the second group I included data from Al, a conservative first generation Chinese Christian; Cait, a white woman who grew up near the local Nisqually reservation; and Meg, a white woman who regularly connected our activities to theories of learning. Locals to the region, these six students were relatively familiar with Indigenous history as indicated in their assigned written reflections. The students' varied identities deeply informed the trajectory of each place encounter and played a major role in their respective perspectives.

Data from an additional third group was used for the purpose of comparison, but was originally unplanned as part of the curriculum study. Undergraduates attending class at the same time as Group Two were led by a different mentor but were taken to the same places except the VR riverwalk. Written reflections from this third group served as a comparison group to gain additional insights into the VR data as it added additional context to insights gained through the digital river walk. Participants from these three groups consented to participating in this research study, and were given the option to opt out.

Data Collection

Over two quarters, I conducted video-based observations during six *place encounters*. Encounters are defined as locations of interest where student groups were invited to explore. The first three place encounters from the first two weeks are highlighted. Encounters ranged from 30 minutes to two hours. Each encounter was organized around the Duwamish River and represented a distinct perspective of the Duwamish as a(n) A) analog place, B) curated place and C) digital place (Figure 2).

(A) (B) (C)

Figure 2. Encounters of the Duwamish. A) Undergraduates walk the River followed immediately by B), a visit across the street to the Duwamish Cultural Center and Longhouse. C) The following week undergraduates visit an immersive simulated representation of the Duwamish River in Google Earth VR.

With the first group of eight participants, GoPro cameras were used to follow threads of conversation and interaction. The second group was filmed using a combination of regular GoPro and VR GoPro Fusion cameras. Students were encouraged to use their mobile devices to capture images and video and were specifically instructed to download Google Cardboard Camera to capture panoramic and immersive 360º *photosphere* images which could then be viewed in a Google Cardboard Camera Viewer (Figure 3) which was handed out during the first place encounter. Students were asked to include their images along with their written reflections.

Figure 3. Google Cardboard viewer and smartphone.

Analytic Approach

Overall, I conducted three phases of analysis. In the first round of analysis, I noted student locations of interest around the analog, curated, and digital Duwamish River (Figure 2c) which I collected in Google

Earth Desktop Pro. I then content logged video data and linked associated image data according to location in Google Earth Desktop Pro. Attending to the VR data, I traced paths of one student from each group, Neil and Al, through both analog and digital space using Google Earth (Taylor, 2014; Shapiro & Hall, 2017). Editing tools in Google Earth made it possible to recreate learner pathways along the Duwamish River and in Google Earth VR which could account for changes along the X (height) axis. Points in time and space were indexed in Google Earth according to action and speech indicating where Al and Neil were drawn to points of interest around the Duwamish River and in Google Earth VR. Paths on the ground and in VR were then analyzed by layering each atop one another and identified according to activity as a way to understand how meaning accumulated over multiple place encounters. In Figure 4, I have mapped paths taken by the leaders of both groups in both physical and virtual space which I refer to throughout my analysis. The dotted line represents paths traveled on the ground, while the straight line represents paths taken in VR. Neil from Group One is represented in blue, while Al from Group Two is represented in orange from the Orange Group. The paths of these two students were selected because of their similarities: they both physically led their group on the ground and were both the first volunteers to try VR. Notably, they also shared a similar background through location (an affluent area outside of the city) and religious affiliation (both were heavily active in their respective Christian churches).

In the field, I observed learners pulling out smartphones to regularly document in 2D and 3D media what they encountered while on the move. These technologies did not displace the need for instruction or social collaboration, rather they centered and facilitated conversation, reasoning, and meaning-making processes. In VR, an activity that centers technology, students gathered around the screen in a classic *O-formation* (Kendon, 1990) reminiscent of research around Joint Media Engagement (Takeuchi, et al., 2011) where the screen becomes a mediator of experience and co-viewing is a social act. This is an especially useful setup in VR where one participant is cut off from onlookers who are able to see what he sees. In my analysis, I use this comparison of paths between on-the-ground movements and in-the-air moments to illustrate locations of interpretive distance as they are linked to the simulated

experience of the River. Their paths were foundational references for analysis and placed the interactions of the other students in context with one another.

In the second phase of analysis, I looked for *claiming moments* (expressions and gestures of surprise) – as an indicator of *interpretive distance.* Claiming moments were coded according to topic and theme. I then triangulated learners' written reflections for added context, and further analyzed participant writing using a Python script to surface word frequency. Excluding commonly used words, the word "perspective" rose to the top, which I coded in Nvivo. I then compared word frequency against a third control group who also visited the same locations focused on the Duwamish River, but did not visit in Google Earth VR. This comparison showed that "perspective" appeared over twice as many times in the first group compared to control, and three times more in the second group. This helped me further develop a set of codes around claiming moments that specifically engaged with comparisons in perspective which I further thematically analyzed.

In the third round of analysis, I identified exemplary moments in the video corpus that illustrated thematic findings across the data. These thematically significant moments were then transcribed, memoed, and linked to the Google Earth Desktop Pro map. Returning to my research questions, I share this data to highlight the tensions and possibilities of a postdigital PBE curriculum.

Context of Encounters

I discuss thematic findings among the two groups together, noting when differences between Group One and Group Two are important to distinguish. The dynamics between members of each group provided two very different learning environments. These differences were set into motion beginning with the first two place encounters that took place on the same day. Undergraduates first arrived at the Duwamish River bank at Herring's Park and then crossed the busy street to the Duwamish Longhouse and Cultural Center where they learned from Duwamish People working at the Center of their histories, artifacts, and struggles for sovereignty. In both groups, a member of the Duwamish tribe spoke with the students. The interactions that followed from that point on served as the starting point from which later

interactions referred. Gadamer refers to this process as entering the "interpretive circle," co-operatively constructed narratives accumulated among encounters (2013). In Group One, initial social justice rhetoric arose following the visit to the Duwamish Longhouse and Cultural Center where a representative of the Duwamish Tribe stopped to talk to the students and share her plea for the Duwamish Tribe to become recognized by the federal government. As we were walking back towards the van, I asked the group what they thought. "I want to cry" answered Ali. In her reflection that week she wrote

> Their sense of ethnic identity was violently erased through white settlement, boarding schools, and so much more. How they were defined is largely remembered historically by the dominant culture.

Following the trip to the Duwamish, Group One was talkative although little of the conversation was captured, seemingly energized for action after hearing the Tribal Representative's call for action. The emotional reactions of Ali, and the first group overall spoke to the distance between what they had been told and believed, and what they had just learned by visiting the cultural center. This example of interpretive distance indicates that Ali's horizon of understanding may have lifted, indicating HEC. It also represents the ways that place encounters addressed incongruences among the stories of the places and the understanding of the students.

The following quarter, Group Two also chatted with a Duwamish Tribal member on the way out of the Cultural Center, however the conversation was started by Al who asked about Duwamish spirituality. As we walked back to the bus, I asked the group what they thought. Cait spoke up first and mentioned how lovely the experience was. "Did you learn anything new?" I asked. "No," she answered and explained that she went to a special school South of here where tribal education is integrated. "Did you live on the reservation?" I asked. "No, educators would come to us." In her reflection she wrote:

> I never knew that the Duwamish people weren't recognized by the government. Even though one of their chiefs is the namestack of Seattle. This trip opened my eyes to how our government has taken so much from the Duwamish people. They have an awareness campaign with the title "This land has a story."

Cait was one of four students to mention the tribe's unrecognized status in her reflection, whereas every student in Group One noted it. These differences highlight the tone that was established for the following week's virtual river walk.

Findings & Analysis

As students explored the Duwamish River through a series of analog and digital place encounters, three dominant themes emerged across the data:

1) Local students were confronted with underlying assumptions of what they expected the Duwamish River to be. Once these assumptions were surfaced, they began to question
2) the difference between official textbook narratives (Williamson, 2006) dominant tribal mythologies (Thrush, 2008) and excluded histories which further elicited critical inquiry into
3) inclusion and exclusion of place representation in both analog and digital encounters.

Analog Place: Herring's Part at the Duwamish River

Challenging assumptions

Few students indicated that they had heard of the Duwamish River, and only three of the group knew where it was despite its central location in the city. Traveling to the Duwamish River was difficult; the size of one group required renting a 12-passenger van as local transport, and even a van could not get us within walking distance. En route, students commented on the fact that they were not aware that the well-traveled West Seattle bridge crossed the River. Many seemed confused that the heavily industrialized body of water located in the middle of the city was actually a river at all. As we reached the top of the bridge I heard Neil exclaim "Wait! Are we going over the River now?" In the rearview mirror phones

could be seen getting pulled out as a few students tried to capture the overhead perspective looking down into the water below. In this claiming moment indicated by expressions of surprise and later by Al who spoke of not knowing he drove over the Duwamish River everyday, Neil suddenly realized the Duwamish River existed underneath a busy central part of the city. In plain sight, their surprise represents the unfolding process of recognition and understanding that underlies HEC. The bridge that crosses the Duwamish River obscures the water itself, soaring over train tracks, shipping terminals, and the most industrial parts of the city. For this reason, the River itself remains mostly invisible to locals who have heard its name, but are unaware of its history or purpose (Thrush, 2008):

> Al: I didn't realize, but I actually cross over this river to get over to West Seattle all the time because I volunteer in West Seattle [laughs].
> Erin: Oh yeah? And you didn't have any idea what body of water you were crossing?

Earlier in class, many of the students talked about how they had heard of the Duwamish River but did not know much else about it. This claiming moment ("I didn't realize") – that the bridge he drove every day crossed Seattle's only waterway – also indicates how the bridge created a kind of interpretive distance for him, enabling him to see the river from a new perspective. He connects the river to his personal experience, and in turn, the experience of the group. For Al, the familiarity of the bridge took on new meaning, and at once this knowledge became interconnected to his own history and identity.

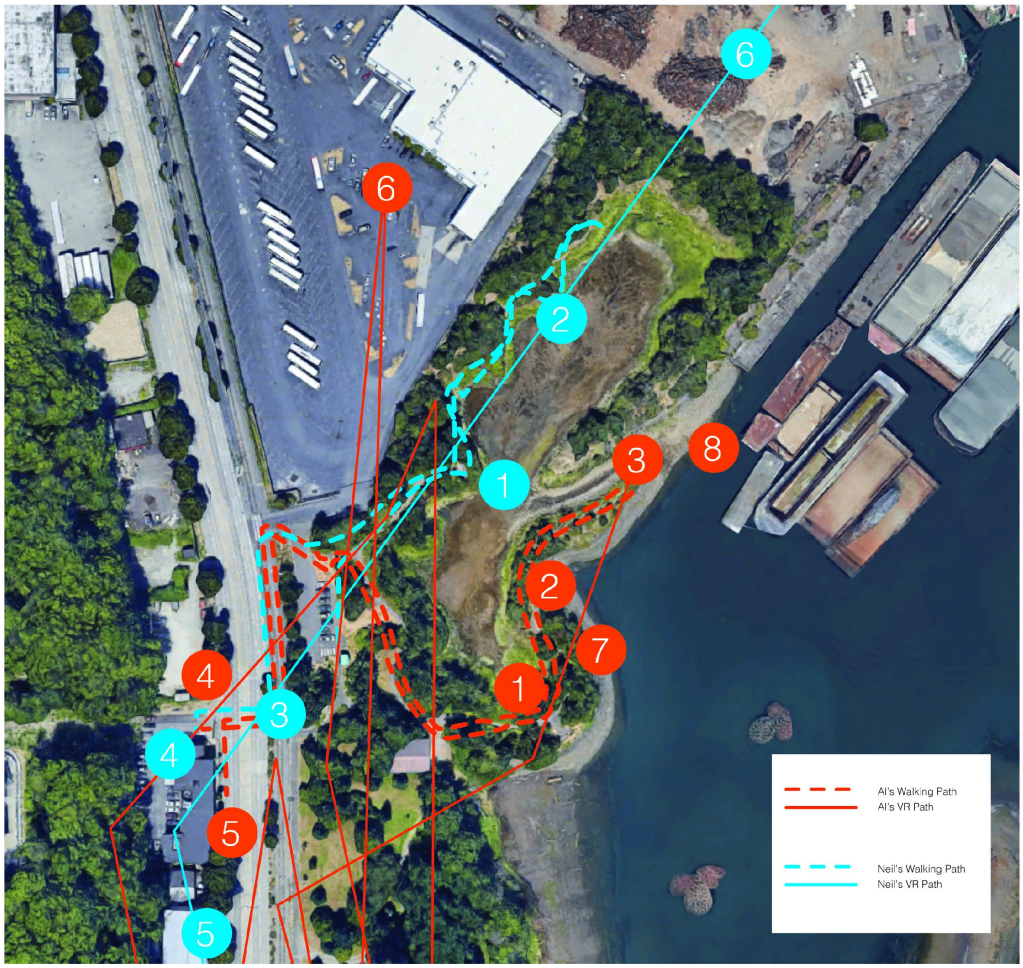


Figure 4. Overhead representation of the Duwamish River as represented in Google Earth. Ground paths indicate Group pathways. VR paths represent only Al and Neil's path (See Appendix B).

Students' first view of the water and initial stopping points are at #1 in Figure 4. Students pulled out phones in unison to take the first set of 360º images with their mobile devices. The state of the River emerged in conversation.

> Erin: Soo, was this what you were expecting?
> Cait: No.
> Erin: What were you expecting?
> Cait: More woods. More like... mud.
> Mia: Less machines [points towards river].
> Cait: [Quietly] Yeah.

Cait refers to the geographic imaginary of what a park *should* look like – a construction that matches the parks of the Pacific Northwest she grew up with. Cait later recounted in her written reflection:

> I was imagining going to a river in the woods. I thought it would be really clean and quiet. It was the opposite. It is very polluted and has an advisory not to eat fish because of the pollution. The river is between factories and a very busy road.

This point of interpretive distance is illustrated by the space between what Cait had experienced growing up and her new experience of the River at Herring's point and illustrates a move towards HEC. The River is no longer an abstract idea to participants at this point; by walking its banks, the Duwamish becomes a real place with a history. She also recognizes her assumptions about what a river *should* be (really clean and quiet), but the reality of the physical landscape "was the opposite." The urban environment, trash, and cargo ships force them to reconsider old information with new. As we continue to walk a few more seconds, Cait (Figure 5) notices the quality of the water for the first time and another claiming moment is indicated by her exclamation of surprise:

> Cait: Oh wow, that's dirty! [reaches for phone to take a picture]

Figure 5. Cait capturing a photo (left), and the photo she captured (right).

The quality of the River was a consistent theme in students' written reflections. Al concurred with others through written reflection that "[t]he river was not the river that we imagined it to be" indicating an

assumption of a shared narrative. Cait included the state of the water in her written reflection and elaborated:

> I noticed that it was very dirty and there was litter everywhere. I saw a sleeping bag and it made me wonder if homeless people come to the park and sleep. It didn't seem like many people come to the park to hang out and see nature.

Cait later recounted in her written reflection that she "thought it would be really clean and quiet," but found it to be the opposite. This point of interpretive distance is illustrated by the space between what she assumed and what she experienced. Cait, along with other students photographed 360º images (Figure 5) along the Duwamish River which they later shared with their classmates in VR via Google Cardboard and their own smartphones.

Panorama Points

Along the physical walk through Herring's Park, two viewpoints along the River inspired students to take out their phone and create a 360º panorama which could later be viewed in 3D via a Google Cardboard viewer and smartphone – an indication that students sought "what they can represent" (Eisner, 2002). These points lack a view of the street and convey the sense of "being there" from every angle. In capturing a 360º, it is necessary to slow down and methodically capture each image of the land. Completed in unison, this shared moment of collective image capture reappeared in immersive VR walks of the land the following week.

Figure 6. Neil's image with classmates also taking 360º panoramas with smartphones. A Northern point along the Duwamish River at Herring's Park as seen in blue #2 of Figure 4.

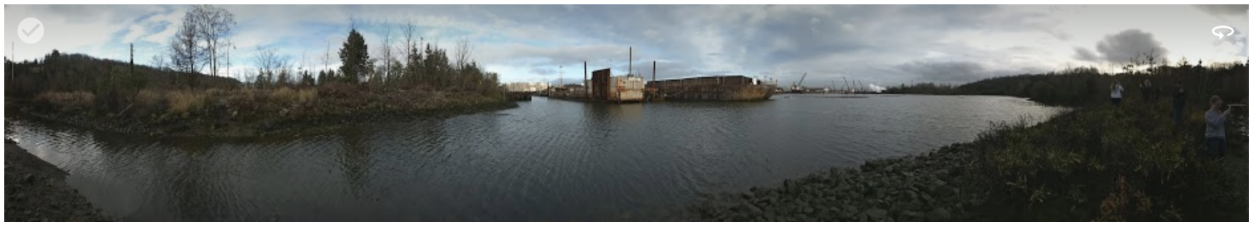


Figure 7. Al's image. ASouthern point along the Duwamish River at Herring's Park with classmates to the right also taking 360° photospheres with smartphones as seen in orange #2 of Figure 4.

The immersive nature of the image when viewed in VR leaves little to the imagination of what is behind the camera; rather, there is a heightened sense that one has captured a piece of "being there" that transcends traditional photography. In giving students viewers to transform their smartphones into VR immersive encounters as a way "being there" again, students saw this as a way to share their experience of place with others. During classroom presentations, both groups set up interactive presentations for their fellow classmates to experience the panoramas in VR for themselves. I posit this desire for shared visual experience is at the root of HEC, and at the root of what students were trying to convey: that they were changed by the experience of the River, and they wanted others to experience something they could not put into words. "...[U]nderstanding is never a subjective relation to a given 'object' but to the history of its effect; in other words, understanding belongs to the being of that which is understood" (Gadamer, 2013: xxviii).

Curated Place: The Duwamish Cultural Center and Longhouse

Eliciting interpretive distance

The site of the Duwamish Longhouse and Cultural Center contextualized students' experience walking along the banks of the River. The current state of the River was addressed through the Center's curated artifacts detailing the history of the Duwamish from the perspective of the Duwamish people. The Center was built by the Tribe in an area of Seattle sacred not only to the Duwamish, but other regional tribes who frequently stopped along the crossing between Puget Sound and the River to rest and exchange goods (Thrush, 2007). Once inside the Cultural Center, carefully curated archives and narratives detail

first-person accounts of settler arrival and the forced removal of the region's Indigenous people.

Getting into the Cultural Center proved challenging despite being located across the street. After walking the Duwamish River for the 20 minutes that time would allow, students headed towards the street (#3, Figure 4) to continue to visit the Duwamish Longhouse and Cultural Center (#4, Figure 4). The road between the Duwamish River and the Cultural Center is a major Seattle highway with no crosswalks. Semi-trucks transporting cargo regularly travel the road as this part of the Duwamish River supports large regional shipping terminals. The lack of transportation and difficulty in reaching the Center was a theme throughout student comments and reflection.

Figure 8. Ali (in turquoise) runs across the busy highway to the Duwamish Longhouse and Cultural Center (#3, Figure 4).

Students quietly wandered around the exhibit and into the Longhouse. Many took 360º images of the inside of the Longhouse which they shared in the written reflections. Towards the end of our time, I began to chat with a Duwamish native who I learned was the renowned activist and Duwamish tribal representative, Cecile Hansen, who shared her ongoing plight for federal recognition as an official tribe. Her talk left an impression on the students as they talked at length about her during their class presentation in reflection:

> Although we moved freely on our own on the trail and in the cultural center, as soon as Cecile started to speak all the students formed around to hear her.

The second Group did not have the opportunity to talk with Cecile, but did meet Blake, a Duwamish tribal member who regularly led guided canoe excursions down the River. Al engaged with Blake in conversation about spirituality and tradition, connecting his own experiences with Christianity. Many of the students stopped what they were doing to listen to what Blake had to say about learning as it is passed down through storytelling, making their own links to the explicit objectives of the class. However, student reflections highlighted ongoing questions about the state of the Duwamish River itself. Al struggled with making sense of the state of the River.

> The heart of the community/tribe settled around [the river] was very different than the spiritual and sacred understanding that Blake had. The Duwamish River was pretty dirty and had lots of boats and industry around it in the background.

Here is another example of students attempting to reconcile the incongruence of the River as it currently existed with his conception of sacredness. Al later writes **"We thought it *should* be enveloped in nature.**" Al was likely claimed by Blake's perspective and use of the word "sacred" to describe the polluted and industrialized River.

Upon leaving the center, Ali mentioned that she wanted to cry: "I'm just so mad we never learned about this in school." The Group had been silent beforehand."Yeah," added Mia. "It makes me angry." The implicit authority of their textbooks, and school curricula had failed them through omission.

> "In my opinion, this is something that should be taught in elementary school: the history of the Seattle area and ALL who have lived here. I also find it upsetting that the Duwamish Tribe is not federally recognized. As the posters in the Longhouse and Cultural Center explain, the Duwamish were the first people to inhabit most of the area we now call King County. Yet the federal government doesn't acknowledge their existence. I am curious as to why that is and what it will take to get the Duwamish Tribe accepted by the government."

The class curriculum for the week focused on identity in sociocultural contexts. Students were learning that place and culture shapes our understanding of the world, and were able to see that perspective through their experiences. After visiting the Duwamish River, Neil reflected in writing that "...[the] [s]ite visit one had a huge impact on me…[w]hat we grow up around generally creates a sense of self." Neil's reflection echoes the assigned reading for that week around *figured worlds*, which emphasize the historicity of self in place and its role in shaping identity (Holland, 1998). In recognizing the lives and perspectives of the Duwamish people, Neil is given an interpretive lens to begin to see the ways his own life has been shaped by the social structures provided by the environment he was brought up in. A core tenant of HEC is that consciousness is understood to be affected by history, but that does not go far enough. Neil must now realize that he is a product of history and is unable to fully rise above it and is unable to see it objectively. Upon reaching that understanding, what is "known" about history is called into question and revisited. "In the process of understanding an historical event or text, we do not take possession of that event; we do not dominate and control it. Rather, we allow it to take possession of us. The event or text comes to life in and through us" (Johnson, 200, p. 35).

The tools and artifacts of the Cultural Center lend itself to temporal interpretive distance as well. "Gadamer says that interpretive distance, especially in the form of temporal distance, should not be approached as an abyss but as a continuity that enables the past to be present. In any situation of understanding, a certain sort of distancing enables us to see the meaning of the situation or subject matter to be understood" (Johnson, p. 31):

> One artifact that stood out to me, was a handwritten letter acknowledging the injustices that the tribe had/still goes through. The artifact was actually signed on July 27, 2015. This shows that not all artifacts have to be decades old to be considered important or noteworthy...Another artifact that really caught my eye was a hand carved canoe. **It blows my mind** because this was once a tool, but now they cannot use that in the Duwamish river. Even though that river is theirs, and they canoed through that to catch fish. Now it feels like an artifact, it is tucked away and will probably never get to see the sacred place.

Mia's claiming moment implies that she assumed Indigenous knowledge was of the past and not present. She realizes the canoe to be a tool to catch fish, which is presently a dangerous endeavor. took away from the experience new ideas of time as it relates to the indigenous history of the River and of Seattle. With indigenous discourse in America, there is always an underlying mythology that what is indigenous and what is urban cannot co-exist (Thrush, 2007). Mia reflects on her ideas of what is past and what is present in the Duwamish tribe. She had visited the Duwamish River in its current industrialized state and was forced to reconcile its former purpose made present in hand-carved canoes. Finally, she does not see the river as sacred anymore despite earlier observations about its maintenance. These are questions of authority and history that had been previously settled. Originally learned through a lens reflective of broader "manifest destiny" values (Thrush, 2007), a perspective of place that countered popular narratives and geographical imaginaries. For Mia, interpretive distance was found in the artifacts she came across – purposely dated to illustrate ingrained assumptions of indigenous history, time, and place. A canoe built in present day, and handed down from the past elicited an embodied response incongruent with the state of the present day River she had just experienced. It is a "continuity of history," in Gadamer's terms that she is struggling to reconcile, and an indicator that old horizons of understanding are under scrutiny. The emergence of questions that surfaced through interpretive distance are evidence of HEC.

Digital Place: Comparing the Analog and Digital River

Surfacing the invisible

The third encounter took place the following week in a local VR lab affiliated with the university. Students were given one task – to locate where they were along the Duwamish River the previous week. After looking around, they could explore as they pleased. Each student was given around five minutes in total to become accustomed to the immersive digital environment. The absence of people in a simulation built by people (i.e., Google Earth VR) was notable in many student reflections. Neil and Al were both the first volunteers to put on the headset and attempt to navigate to the Duwamish River in the VR

environment while their classmates watched. Upon entering Google Earth, the ground appeared to be thousands of feet below. As they gained control over the handheld controllers, both Neil and Al circled in over the city of Seattle and then located the port that led towards the bridge that crossed the Duwamish River. Onlookers watched as participants navigated the limited 12 X 12 space to move around; but most used the controllers to point and teleport in the digital environment. Students stood in an *O-formation* (Kendon, 1990, Figure 9) facing towards a screen that displayed the participant's viewpoint. This configuration allowed students to look at the screen and see the VR participants' perspective, and then back over at the participant's embodied actions.

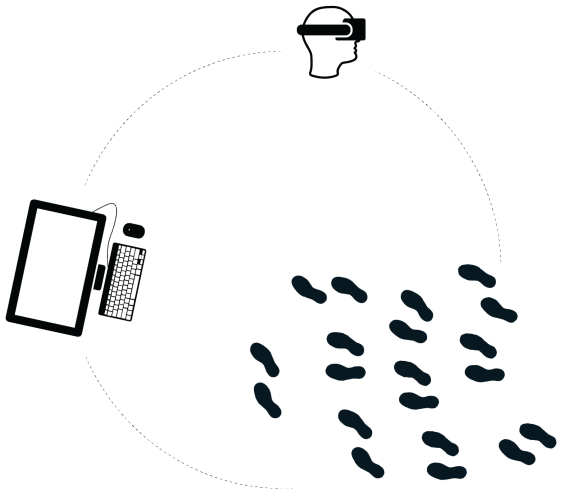


Figure 9. VR lab O-formation: screen, observers (shown as footprints), VR participant (Kendon, 1990).

While viewing the screen, classmates would try to direct the participant in the direction of the River – initially by pointing out of habit, but then eventually switching to cardinal directions when they caught themselves gesturing despite knowing their headset-wearing classmate could not see them. Al's perspective on the screen served as a diagram, a mutable representation (Goodwin, 2018; Peirce, 1931) for learners to reason through. Surrounding information was taken in by the VR participant and onlookers to recreate their experience. This technological configuration allowed for group resharing of past experience, as students could gather around a screen displaying the participant's perspective as they navigate through the simulated world. The VR simulation of the Duwamish enabled students to revisit

past shared experiences as a way to elicit interpretive distance between what they had just encountered at the analog River, and what they see in the digital rendering of the digital River in Google Earth VR.

Figure 10. Neil (right) and Al (left) try Google Earth VR first in their respective groups.

I replicated "flight paths" through Google Earth VR on the x, y, and z axis in Google Earth for further analysis. While these paths are not representative of exact movements in space over time, Google Earth does allow for a visible dialogue between data on the ground and data in the air – the digital sky of Google Earth VR. In this dialogue, I pulled out moments where the virtual landscape provides Neil and Al with interpretive distance of lived experience of the Duwamish from the week before, and note questions that emerge among the group as they reflect on the immersive representation of the River. I use Neil and Al from either group to demonstrate the different kinds of moments and movements that occurred among the two groups.

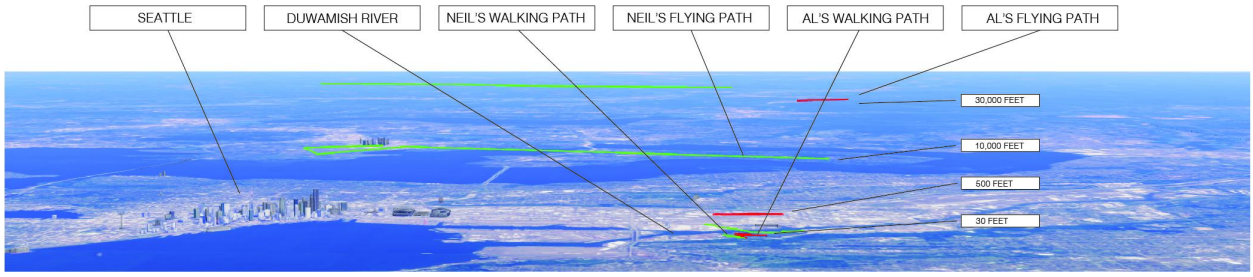


Figure 11. Neil (green) and Al's path (red) through Google Earth.

Neil entered the simulated world at a lower elevation than Al from Group 2, but covered more ground orienting himself by identifying the tall buildings of downtown Seattle. He then traced the River from the bay and recognized the Cultural Center which his classmates pointed and gestured to in unison. Upon identifying his destination hovering thousands of feet above the water, he asks "how do I get down there? (#5, Figure 4) ," presses a few buttons on his controller, and then descends to around 500 feet. Neil reasoned out loud that he could follow the highway along the park and recognize the train tracks from the week before to do so. "There it is!" At this point Neil raises his head towards the virtual city, elevates himself, and "flies" his way to the stadium. "Anyone want to watch some football?" he asks while hovering above the sports field. He suggests playing football, but there are no people represented on the ground. The idealized snapshot of the virtual world is coherent in its ideal (Massey, 1994), free from people and human activity. The simulation contains structures built and used by people, like the football stadium, but is limited by the timescale it displays. It is an authority, a "specificity of place," that is "continually reproduced... [B]ut it's not a specificity which results from some long, internalized history" (Massey, 1994, p. 154). The ephemeral digital landscape stood in stark contrast to the artifacts and materials produced by the Duwamish people and on display at the cultural center. Similarly, the walk along the digital River banks belied the realities of the polluted River they encountered the week before.

The absence of people in a simulation built by people was notable in many student reflections. For example, upon entering the simulation, Al was claimed by the sheer height that he soared through the air. However, it was the absence of people he elaborated on in his reflections:

> I feel like that was what the VR experience showed me….is that we did not get to see anyone there during our experience and learning. Relating people to their context is something that requires real people to show their real story.

Similarly, Cait thought the experience was amazing and loved that she could "do things I couldn't do in real life,", but "quickly realized it was totally different from being there in person."

> It looked much cleaner in VR. In VR you couldn't get the feelings of actually being there. I couldn't hear the sounds or smell the air. I did not gain that personal connection of actually being there. I couldn't interact with people there.

As Ali traveled along the Duwamish River, she remained in constant conversation with her classmates. The above-ground angle was difficult for her to translate to on-the-ground experience, and she relied heavily on her classmates to navigate her around the world. Once she had reached the area, hovering high above the land, Ali exclaimed "**I don't recognize anything.**..oh wait, is that the River? It's so blue!" Ali's later reflection about "knowing history versus just seeing a location" connects to the incongruence she felt between her digital and analog experiences. Similarly, Cait thought the experience was amazing and loved that she could "do things I couldn't do in real life," but "quickly realized it was totally different from being there in person."

These students from two separate groups, both carried the embodied sense of being at the Duwamish which they struggled to reconcile with their experience in the digital world. In both cases, after visiting the Duwamish River in person and later the next week in VR, they noticed the lack of people and the absence of history. These observations point to larger questions about representation and authority that they likely would not have been thinking about if they had only visited the River in real life or in VR. In the next section, I investigate examples where participants compared their VR experience to their previous experience.

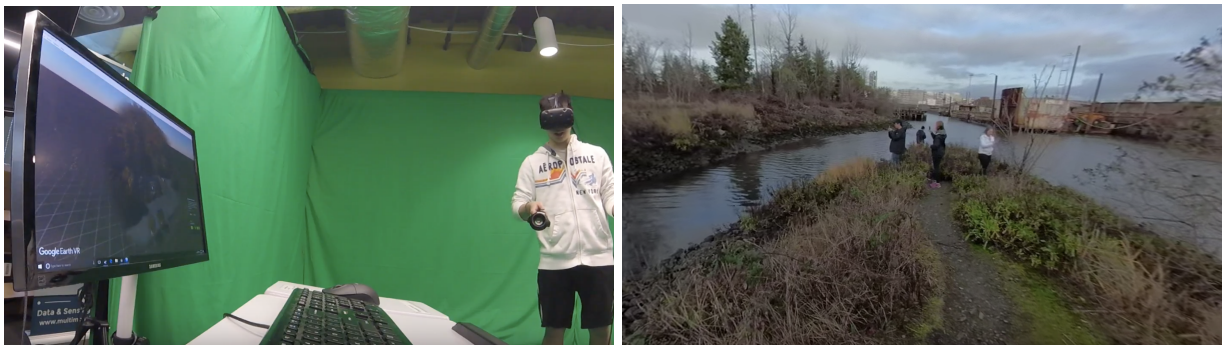
Interpretive Distance: Comparing analog and digital encounters

Neil spent the majority of his remaining time "flying" over the city and views it in its entirety (Figure 11). He later noted that he wanted to see his house, possibly as another object of interpretive distance to compare. VR had made the familiar unfamiliar (Bell et al., 2019), and he was looking for points of recognition. Figure 11 shows the heights and distance made possible in VR, and represents the truncation of time in covering these distances (5 minutes) as compared to the dotted path of Figure 4 which represents a 25 minute duration hike on foot.

By contrast, Al's journey was far more directed towards the Duwamish River. After a quick hover over the city, Al immediately spotted the River and Cultural Center below, and descended until he reached street level. He then used his controllers to walk: the path taken the week before along the River. After walking the shore for a few seconds, he eventually recognizes the point where he and his classmates collectively took a 360º photosphere of the park (orange #3, Figure 4).

> Al: Oh, we were on this thing! [gesturing towards the viewpoint]
> Students: Yeah!
> Al: We were like...I was taking a video like right here!
> Erin: Good job spotting that. You're standing in the exact same spot, aren't you?
> Al: Yeah, like here's this old boat. And this weird thing. There's like some water there...here's like everything else. Wow. But I don't see the trail.

(A) (B)



(C)

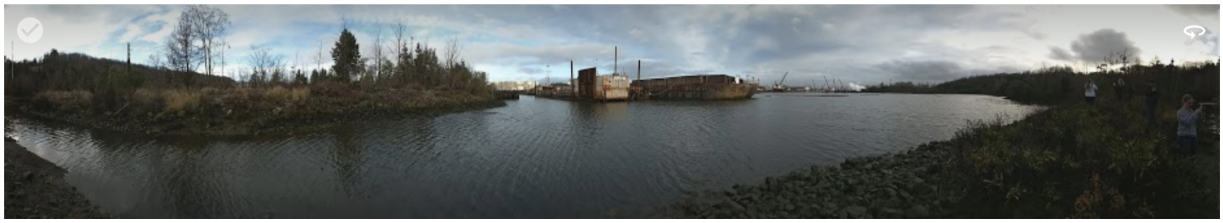


Figure 12. Al navigates (A) to the point along the Duwamish River (B) he took a 360º of the previous week (C).

The locations where students took 360º panoramas served as markers of shared experience of the land. Al remarks "*we* were *there*," and the students' confirmed Al's declaration, linking together multiple perspectives of the River. Using the simulation as a diagram, Al relied on the shared experience of

walking the Duwamish River to revisit the Duwamish River's shared meaning with his classmates. As Al talked through his VR journey, his statements set the tone for later experiences which can be traced through the initial experience of the River.

The VR simulation became an important part of interpreting the differences between what was experienced the week before, and what the simulation showed. When I asked Al what looked different, he immediately noted the cleanliness of the simulated River.

> Al: "Uh it looks...uh kinda...it looks...there's not trash on the ground."

The cleanliness of the simulated River was overwhelmingly what students noticed was different between their experience from the previous week and the simulation. The VR experience raised questions around representational validity, especially after visiting the River in person. Mia remarked "I don't remember seeing the green of the River," recalling her experience from the week before. Another student not featured in this data, seemed equally surprised "It's so clean and sunny!" she exclaimed upon entering the simulation, thus establishing its representational validity between her lived experience, and the digital Google Earth environment.

Mia's written reflections echo Massey's concern with coherence and recreated specificity:

> Going more in depth with what was seen, the perception of the Duwamish River that was enhanced in the virtual reality did not look anything like what we had seen in person. For example, the VR showed the river that seemed like nothing was wrong with it and how the color of the water seemed like there was no effect to it.

Ali's thoughts were similar:

> The VR version made the politics surrounding the Duwamish not the most salient thing about it when looking at it. Knowing history versus just seeing a location can play a big role in understanding the impact space, place, and the significance that carries.

Because the curriculum was postdigital and thus included the digital River as rendered by Google Earth, youth were open to questioning their local history side-by-side encounters of authoritative representations thus recognizing that only certain narratives are represented by any one encounter.

The virtual simulation created an embodied disconnect between what was learned the previous week, and what the digitally simulated River showed them. This fundamental incongruence between what was known before coming to the lab, was experienced in VR provided the interpretive distance that elicited comparative differences. These differences became contentious points of reflection for students who began to grapple with dominant narratives and the limitations of place-based histories. Wandering through the digital River, they began to critically question historical and representational sources. Among the two groups, critical questions about history and authority pervaded their written reflections and emerged through conversation during VR sessions. For example, Cait spontaneously drew connections to the book *Fahrenheit 451* and the interactive entertainment centers designed to provide mindless entertainment within the dystopian society.

> Cait: Have you ever read *Fahrenheit* 452*...1*?
> Student: Ok it's in my bucket. Like I have a bucket in my room. And I like have it in there. But I haven't read it. I bought it.
> Cait: It actually kind of reminds me of it...because like, in the beginning they're in a big room with four big screens. Like, it's like virtual reality.
> Student: I didn't know that. Okay.
> Erin: Which book are you talking about?
> Cait: *Fahrenheit 451*. Have you read that?
> Erin: Oh yeah, a long time ago. I totally forgot about that part.
> Cait: Yeah they're like... she's like. You can buy into be on your favorite TV show, and you'll have like a line, and you're literally living in a tv world.

In relating her experience to Ray Bradbury's Fahrenheit 451, Cait called upon her experience of the book to make sense of the virtual world – of its incongruence to other stories. By linking the hidden history of the Duwamish to the book and history-less world of Fahrenheit 451, Cait demonstrates the kind of interconnected reflection that is made possible when multiple, comparative encounters of a place become

the teachers: learners' are invited to consider to the conflicting stories that they may or may not have been aware. Cait's group followed a much different learning trajectory from the first as they were not as surprised by what they learned based upon their reflections and reactions. Cait herself mentioned that Indigenous education was part of her upbringing and very few incidents in the data allude to HEC; however, her connection to the relevance of *Fahrenheit 451*, a book about destroying heterogeneity speaks to the power of eliciting interpretive distance through a postdigital curriculum of place encounters.

Discussion

In this paper, I explore three place encounters to demonstrate what a postdigital pedagogy of place might reveal. I show how young people were invited to consider multiple heterogeneous encounters of places across three analog and digital sociopatial configurations as part of a larger curriculum. By placing the encounters alongside one another, students were able to position their own understanding in contrast with the many narratives and spatial encounters they were challenged to reconcile. A postdigital philosophy posits that through complexity, discernment is elicited as underlying congruences are reinforced while incongruencies are confronted, challenged and pitted against dominant place narratives. A postdigital place-based curriculum design closely resembles the kinds of authentic place encounters that we all have: looking a place up on a map, Googling a bit of history, and wandering around an area. These are practices that I argue should be incorporated into place-based education as they are closely aligned with everyday life.

Through a postdigital lens, I demonstrated how one might design for epiphany, or the kind of deep understanding that youth demonstrated when they realized that their understanding was informed by partial histories, dominant narratives and geographic imaginaries (Gregory, 1994) These deep realizations cannot be elicited through direct address, but must happen on the part of the learner when they are ready to open to and confront their underlying assumptions and admit that there are things that they do not know that are products of the time and history they were brought up in. And so just by exploring multiple

encounters of a place thereby embracing heterogeneity, I was able to elicit interpretive distance, the precursor to historically effected consciousness, by juxtaposing multiple encounters alongside one another. Without a specific content-driven end goal which would have narrowed the PBE outcomes, I tried to set the stage for students to open to being changed, moved and challenged by individual encounters.

Throughout the data, I identified claiming moments that indicated the possibility for HEC while fully recognizing that I could not definitely state that such a level of understanding had occurred. However, I found that by presenting the multivoiced complexity of a place through multiple narratives and encounters as a pathway to achieve HEC elicited deep reflection and critical thinking by the students. Had digital considerations been excluded from this experience, the students in the study would not have had the chance to make connections between dominant, persistent narratives and the digital geographies that underlie and reinforce them.

Eliciting Interpretive distance in postdigital PBE settings

Interpretive distance facilitated through emergent spatial technologies, like Google Earth VR and Cardboard, open up possibilities for further postdigital investigations into dominant place narratives. The sociomateriality of place encounters like those in Google Earth simultaneously enable new modes of interaction and exploration, yet abstract the experience of place from history, people and context. Notably, students wished to see familiar places almost as a way to gain their bearings in the digital world. To encounter a familiar place in an unusual setting elicits a great deal of interpretive distance: for example, Al was able to stand at the exact point of the Duwamish River where he had stood the week before and noticed how different it looked from encounter along the riverbanks the week before. It is debatable that this experience raised his horizon of understand; however, by virtue of the curriculum aiming for openness and postdigitality, they all demonstrated the kind of critical thinking and discernment that is essential to understanding the ambiguity and complexity of places and histories in the digital age.

However, traditional PBE practices exclude digital engagement to avoid distorting the true experience of a place. Through the curricular argument I present in this study, I showed how digital place-based engagement and deep historical understanding can and should exist in a way that reflects real world learning and authentic digital experience. Through the incorporation of digital narratives, I opened up opportunities for learners to consider how powered digital narratives like Google Earth can masquerade as a dominant voice of representational authority, thus opening the door for learners to consider the validity of other narratives. Postdigital pedagogies are crucial to address the kind of limited uncritical discourse that passes for absolute truth on Facebook forums and on the Internet more broadly. Applied to place-based education, a postdigital pedagogy of place involves engaging with the complexity and incongruencies of place histories and stories which I posit is possible through interpretive distance, comparison and the cultivation of deep understanding and discernment.

The similarities and differences become far more visible and the learner is able to ascertain what is real and what is not. This theory of learning is closely aligned with Karen Barad's agential realist theory of diffraction where reality is not understood through a stable reflection of a sign, but through differences among signs (2007; Harraway, 1996). Approaching a theory of learning that relies upon difference rather than the memorization of signs and symbols (information) is essential to postdigital learning. As boundaries between the analog and digital world blur and overlap, information discernment will become increasingly necessary. The alternative is to continue to exclude the technologies that inform our understanding and instead attempt to train educators to remain the definitive expert in the room. While there is inarguably a need for educator training around postdigital issues (Knox, 2019), a paradigmatic shift would likely be far more effective.

What is real?

The design of this curriculum began loosely with Haraway's theory of situated knowledges (Haraway, 1988) as a way to think about possibilities for what postdigital heterogeneity might look like. The

philosophy of Hans Gadamer emerged as it became clear that places were doing much of the teaching. Students were surfacing assumptions I did not know they had; simply by encountering a series of places these local young people were looking at their home in a new way (Bell et al, 2019). Gadamer's theory of HEC most closely described this process and I was able to apply it as a design methodology. For that reason, Gadamer is also useful when looking to understand the kinds of questions young learners were grappling with as their *horizon of understanding* increased. For example, as Ali traveled along the digital Duwamish River, she remained in constant conversation with her classmates and continually commented on the aesthetic differences of the River which alerted her to the importance of not separating out its history. Gadamer's words (2013) can be heard in Ali's observation:

> Not just occasionally but always, the meaning of a text goes beyond its author. That is why understanding is not merely *reproductive* but always a *productive* activity as well…. Understanding is not, in fact, understanding better, either in the sense of superior knowledge of the subject because of clearer ideas or in the sense of fundamental superiority of conscious over unconscious production. It is enough to say that we understand *in a different way, if we understand at all* [emphasis added] (p. 307).

The undergraduates engaged in this postdigital PBE study reflect Gadamer's (2013) words in the way their levels of place understanding differed according to their own assumptions. These multiple place encounters were designed to open young learners to other stories and other perspectives that may have run counter to their underlying narratives and assumed biases. In these situations, it may be tempting to correct assumed prejudices and biases by sharing an official "correct" narrative. Yet, a postdigital approach would caution against this method of teaching as well because it advocates for yet another (albeit different) single, authoritarian source of information. Overall, the most effective educators in this postdigital curriculum were the places themselves and the incongruent histories students were left to reconcile. This study advocates for the inclusion of the digital in all its spatial configurations to elicit the kinds of insights young learners reached in this study. The future of place-based education and beyond

would be well served by the introduction of postdigital methods to prepare young learners to thrive in our postdigital world.

PAPER THREE: **LEARNING ALONG POSTDIGITAL LINES**

Abstract

Visual renderings of physical places matter for how young people learn about their homes and communities. Technologies of place – of navigating, negotiating and producing spatial "stories-so-far" (Massey, 2005) are rapidly blurring boundaries along the analog and digital continuum. In this paper, I consider the emergent cartographic projections of Google Earth and follow young learners as they travel through it to learn about place. I adapt a *learning along lines* unit of analysis (Taylor, 2017) to gain insight into young learners' patterns of movement and engagement as they bridge analog experiences with Google Earth interactions. Using first-person VR and desktop video of youth traveling through Google Earth while engaged in a digital place-based learning curriculum, I use the data to produce lines of movement through familiar digital spaces from a series of first-person frames recorded from the learners' perspective. I then apply a rhythmanalysis lens (Lefebvre, 2017) to describe the rhythmic movement and tempo with which youth moved through Google Earth travels in VR and on the desktop. By comparing *lines of learning* produced through the two distributions of Google Earth, I align patterns of movement with temporal engagement thus demonstrating a new way to think about learning along postdigital lines.

Overview

Networked digital geographies and the devices they operate on are creating increasingly complex arrays of visually and textually rich experiences through which we engage with place (Leszczynski, 2015). The fidelity of digital geographies have become increasingly detailed and visually realistic by connecting analog encounters to realistic digital representations. The blurring of analog and digital place encounters create new opportunities for spatial engagement that recursively contribute to analog experience and sensemaking (Farman, 2012). For example, I can virtually "walk" the path from the train station in Milan

to my hotel without ever leaving home; or "watch" the sunset on the solstice in Fairbanks Alaska from my home in Seattle. Visually, these experiences in Google Earth are increasingly realistic and can now be accessed through virtual reality (VR).

This new kind of digital mobility – one that allows people to learn about places by navigating realistic visual models of analog spaces – challenges our conventional understanding of place based education. Doreen Massey (2005) helps us think through these challenges; she proposes that space is constituted through interactions, that it is heterogeneous and plural, and that it is a product of "embedded material practices which have to be carried out…always in the process of being made" (p. 1). These material processes matter, but are often couched in dualistic terms where the materiality of "virtual" digital space is separate and considered to be a tool to learn about "real" analog space. Now that Google Earth can be explored immersively in virtual reality (VR), it has become increasingly difficult to overlook the material qualities of digital mobility. The rise of the *Metaverse* and the soon to be released Apple mixed and augmented reality (MR/AR) glasses have further sounded the alarm to think about place beyond analog/digital dichotomies (Bibri, 2022). In this paper, I ask how we might think about learning and mobility given this new analog/digital reality? I consider Google Earth as a site of place-based learning, and observe how learners move through and engage with its environment on both the desktop and in VR. By observing how learners move through and engage with cinematic visuals reconstructed from satellite and on-the-ground frozen-in-time imagery, I present new methods of thinking about and analyzing digital place-based learning.

Postdigital Place-Based Education

Place-based education (PBE) has grown in popularity over the years, offering opportunities for youth to engage in authentic and experiential engagement with places, yet traditional PBE pedagogies have largely ignored the role of spatial technologies in children's sense-making of place and tend to position technology as a hindrance to PBE rather than an asset or integral aspect of it (Sobel, 2013). In Greenwood's 2007 treatise on critical PBE, he addresses PBE uses of technology, while positioning it as

an accessory to place, claiming that technology "...limits, devalues, and distorts local geographical experience" (Greenwood, 2007, p. 8). Recent research alludes to the possibilities of expanding PBE to include technology rich practices like *learning-on-the-move* pedagogies (Marin et al., 2020; Taylor, 2017), visual spatial tactics and participatory mapping (Elwood & Leszczynski, 2010; Elwood & Mitchell, 2013, Taylor, 2013) but have not explicitly positioned digital place as a legitimate aspect of PBE. The digital geography activities in this study investigate a *postdigital* (Jandrić, 2018) approach to PBE. Postdigital education positions technology as an integral part of learning rather than a novelty or obstacle, thereby returning the focus back on learning processes and outcomes (Knox, 2019). In this conceptual exploration, I apply a postdigital lens to learning along lines pedagogy by following middle school-aged youth across digital places as they configure digital space into place.

I focused on two main activities that emerged from previous research questions centered around youth engagement in Google Earth VR – mainly why participants were drawn to their digital homes. Upon arrival, participants would inevitably use the digital environment to "time travel" to see their old house, visit friends, and then their parents,' families,' and childhood homes as a kind of "homing instinct" (Silvis, 2018). In response, we designed activities centered around the analog and digital neighborhood where youth were given ample opportunity to travel along the analog-digital continuum as part of their PBE curriculum. Youth were asked to explore their neighborhood immersed in Google Earth VR, trace through their personal place histories by using Google Earth's tour builder to create *geobiographies* (Kahn, 2019), and reimagine place encounters through Twine-based *choose your own adventure* storytelling.

Engaged in digital place-based encounters, the young people in this study were open to consider disparities between their lived experiences, memories and novel and mundane digital encounters while in the process of making sense of their own histories. Compared to their analog and speculative place encounters, Google Earth offered something materially different and extraordinary for young learners to learn with and through. As I followed young people across analog/digital lines of learning, I asked:

How do young people learn about place and history across digital geographies of their analog homes and neighborhoods?

Digital learning on the move

Google Earth can be accessed across networked devices, including through VR. VR's immersive capabilities raise questions about how people move through digital spaces, especially one that is tied to analog places. And through movement, how do they learn about space and place in these environments? How does immersive movement differ from desktop movement in Google Earth? In analog environments, the organization of spatial encounters affect patterns of rhythm and movement (Lefebvre, 2017); does the same hold true as learners move through digital geographies like Google Earth? To better understand *how* learners move through Google Earth and subsequently learn about their home and neighborhood along lines of movement, I turned to the visual qualities provided through Google Earth. The illusion of "movement" is produced through Google Earth through changes between visual frames in much the same way movies depict moving images. However, unlike in the movies, movement is determined by the actions of the person in Google Earth, thus mimicking the experience of walking through the city or flying above the land. This illusion of movement created via realistic models of analog places, creates the visual impression of being in a movie. I describe this visual quality of Google Earth as a kind of *cinematic geography* that in its realism, reifies the connection between analog and digital encounters of space.

The first-person point-of-view (POV) perspective is of particular interest to mobility researchers who investigate the mundane, everyday experiences of our spatial lives and the devices we use to engage with them. While wearable cameras have revolutionized "learning on the move" (Marin et al, 2020; Taylor, 2018) through the liberation of the *action camera* (Kindt, 2011), the footage generally does not accurately capture the gaze and interest of the camera wearer (Pink, 2013). Following interactions through first-person POV in VR offers a unique insight into digital mobility that extends beyond GoPro camera imagery. In this study, rather than extract data from action cameras, I used screen recordings to follow Jay's VR first-person POV as he explored his neighborhood in Google Earth VR. Jay's POV allowed me

to see into learners' engagement with the immersive digital world. Through screen recordings, I analyzed movement through the view of the learner and produced lines of learning for analysis (Taylor, 2017; Shapiro et al. 2017). I could see where they pointed, what they clicked on and what they found interesting. This data presented an exciting, yet challenging corpus of information to analyze movement and learning through cinematic representation experienced as a first-person POV.

New cartography, new consciousness

Google Earth represents a different kind of cartography where the distance between abstract spatial representation and lived experience meet in an *uncanny valley* (Mori, 1970) of an "almost real" reality. "Art transforms the improbable into the inevitable" Jonathan Beller quotes composer Pierre Boulez in the introduction to his book *The Cinematic Mode of Production* (2015). Beller argues that in the rise of visually rich geographic applications like Google Earth VR and the *Metaverse*, place has fused the moving pictures of cinema with social spaces and interaction. Created solely through changes in visual frames that render scale models of analog places, cinematic geographies (like Google Earth) call for new digital methods of thinking about movement and learning. By attending to *lines of learning* produced through Google Earth, I echo Jen Ross' (2023) insight that new methods of speculative analysis can offer new insights into the future of learning. For example, Bernard Stiegler (1998) and others caution how dissemination of the cinematic hijacks the imagination through visual culture and spectacle (Horkheimer & Adorno, 1972; Debord, 1983) which then serves to structure modern thought though language (Deleuze, 1989) and visual grammar (Kress, 2006). Together, these theories point to the underlying agency of the environment to shape our ways of knowing and being (Herrenkohl, 2010; Vygotsky, 1978). And it is through the emergence of our collective *cinematic consciousness*, Stiegler argues, that we organize time and memory (1998). Through my data, I show how learners organize time and memory through patterns of movement and engagement.

The rhythm of time-images

While youth were navigating Google Earth, I observed them engaging in temporal observations and recollections that rhythmically flowed with the digital environment. This observation is reminiscent of Gilles Deleuze's claim that the liberation of the camera reveals time rather than space (1998). Deleuze's theory is a continuation of Bergson's claim that consciousness is movement; it is never still (Bergson, 1912). This idea is helpful to think about place learning through the series of cinematic frames that convey movement for learners as their POV is also the camera. VR provides the learner with a view that is the camera, and has been shown to alter time (Bailenson, 2018). Movement, according to Bergson, creates duration (dureé) or time. Deleuze brought this idea into the cinema where the movement of *time-images* places us in dialogue with the past, while forcing us into the time scale dictated by the camera (Stiegler, 1999). In other words, the images of cinema are always captured in the past, while the movement of images conveys the passage of time. Similarly, I observed youth grappling with questions of time as the images they encountered in Google Earth were sourced from the past, but their experience of moving through the digital space placed them into a sense of the present. In my own analysis, I found that by tracing lines of learning I revealed learners' connections to time that varied according to the materiality of the digital environment thus demonstrating its agency in place learning. These connections aligned with how young people negotiated their identities (boyd, 2014) and shared their personal narratives (Ito, 2005) in the project.

The cinematic – grammar, cut, and sequencing of images that made up the frames that created paths – became important in my analysis of learning along lines because of the visual environment Google Earth is founded upon. Youth produced movement via changes in visual frames that were composed via a rendered simulation or connected panoramic images – essentially simulating movement like we would see at the cinema. Only, the youth controlled the camera and thereby the pacing of the frames. In this study, I follow interactions between learners and viewers as they engage in interaction and conversation along lines of learning. By attending to interactions, I observed distinct rhythms of interaction made between youth and the digital environment. "Everywhere there is interaction between a

place, a time and an expenditure of energy, there is rhythm" (Lefebvre, 2017, p. 8), and these rhythms were determined by the materiality of the digital environment demonstrating the significance of learning along lines through cinematic, digital geographies like Google Earth.

Methods

Context

For this paper, I included data from two postdigital place-based curricula implemented with middle school-aged youth. I collected these data over the Winter of 2019 and 2021 as part of STUDIO's afterschool STE(A)M programming. Each 10-week curriculum featured Google Earth interactions, but due to COVID restrictions, only data from 2019 included VR interactions and analysis.

The two postdigital place-based curricula were situated within a broader study that aimed to reframe STEAM education as part of a research-practice partnership called STUDIO (Herrenkohl, et al, 2018). Through this research-practice partnership, undergraduate STEAM majors worked closely with program youth to engage in STEAM-related projects. STUDIO staff, researchers, and mentors worked with the community to develop curriculum designed to counter deficit narratives of immigrant and refugee youth by reframing and expanding upon the narrow definition of "what counts" as STEAM education (Vossoughi & Vakil, 2018). In the curricula I implemented with youth and STUDIO staff, I intentionally centered youth in asset-based narratives of their home and neighborhood (Coleman & Davis, 2020) via place-based curricula that contextualized their personal and familial narratives around place, family and identity.

Curriculum

As mentioned above, two 10-week curricula provided the data for this postdigital PBE study: one conducted mainly in Google Earth VR, and one conducted mainly with the desktop version of Google Earth. Due to Covid protocols the central curriculum highlighted in this paper, *Bread & Building*, was

designed and implemented over Zoom. Working with STUDIO youth, we were able to apply a postdigital place-based learning lens to an earlier Zoom cooking curriculum (Lee et al., 2023). This adaptation contextualized the recipes youth were learning to cook (breads of the world) to different locations familiar to them and their families. In the VR data collected during a previous session, youth were especially interested in "traveling back in time" to places from their past or their family's past. Following their lead, we integrated *geobiography* (Kahn, 2020) activities to observe learners' movements through digital geographies.

Geobiographies encourage young learners to engage with digital geographies intergenerationally as an activity to contextualize and bring together familial narratives. Supported by cross-cutting STEM learning goals, each week we blended chemistry-based baking lessons with geography to emphasize the everyday STEM practices that people around the world engage in through cooking and baking (Lee et al, 2023). In addition, we invited youth to build stories around the countries we explored using the interactive web-based storytelling tool, Twine (Sater & Mouthrop, 2021). Twine provided youth with basic html practice, and most importantly allowed them to collect images and embed maps into their "choose your own adventure" stories. Analytic insights from the VR data informed the design and analysis of the later Zoom-based curriculum. Multiple methods of digital place engagement ensured a rich dataset of lines produced across different contexts.

Participants

The youth who participated in this study were middle to high school age and were supported by young undergraduate members. Youth participants were long-time members (two or more years) of STUDIO at the time of the study. All of the youth were very familiar with STUDIO and the staff. Only one youth, Moh a Somali refugee, had not participated in the earlier VR curriculum as he was too young to participate having just begun middle school that year. A homeschooled brother/sister duo, Don and Dee, a middle and high schooler with Jamaican and Indigenous heritage, had been regularly attending for the last three years. Minh, a Vietnamese young adult, was in his second quarter of college, but continued to

regularly attend with his younger brother. Despite not really needing a mentor, Minh found himself in a unique position to learn how to become a mentor himself while continuing to connect with his family. Together, close analysis of first-person perspective data from these five participants illustrate broader themes of learning about place through the digital environment. Mentors and STUDIO staff are included as part of youth's digital engagement as they were companions to youth as they went on their digital adventures.

Data Collection

I collected data from 5 hours and 51 minutes of screen recorded videos of youth exploring Google Earth in virtual reality (VR) along with 7 hours and 21 minutes of youth and undergraduate mentors using Google Earth on the desktop over Zoom to complete place-based activities. Additional video data (totaling 16.5 hours of collaborative cooking instruction and multiple break-out room activities) was also content-logged. Geobiography maps and interactive Twine stories were collected shared on a collaborative web-based Padlet page that served as a central place to share tours, gather recipes and copy and paste bits of html code to use in Twine.

Positionality

Relationships were central to the success of this research. I joined the afterschool STEM research-practice partnership (RPP) that made this study possible in the Spring of 2018 initially as a participant researcher, and then later as part of the curriculum design and research team. During my three years of involvement, I became well acquainted with a core group of seven youth who regularly participated in the STEM sessions my colleagues and I co-designed, facilitated or observed (Lee et al., 2023; Taylor, 2022). Upon joining the team, I relied heavily upon the strong foundation of trust and respect established by the RPP founder and fellow colleagues (Lee et al., 2023; Herrenkohl, et al., 2019). Because of this existing relationship, I was able to work closely with youth at the scale of the neighborhood to co-develop a

place-based set of activities that positioned youth as place experts and myself and my colleagues as facilitators and fellow explorers. This spirit of exploration and imagination at the scale of the neighborhood (and eventually beyond) empowered youth to explore and seek answers to questions I would not have ever thought to ask, while destabilizing the power dynamics that underpinned my identity as a white woman researcher.

Analytic approach and Preliminary Findings

The data analysis process began with content logging video records of youth engaging with Google Earth (and sometimes Google Maps) in tasks related to exploration, home, and identity in VR, on phones and on the desktop. I coded youth's places of investigation and looked for patterns among the locations. Noting similarities in youth's interest in location themes (home, friends' houses, and school), I looked for thematic patterns in the order of investigation, action, and speech while noting the temporal aspects of each. In the spirit of Deleuze, I attended closely to these patterns of engagement created through lines to identify how Google Earth contributed to youth's organization of time. My major analytic question involved understanding the contextual differences between cartographic representations. In other words, *how does learning about place through Google Earth in VR differ from other windowed environments? Does the immersive environment elicit temporal thinking in ways the desktop environment cannot? What can this tell us about the emergent relationship between the cinematic and the temporal, and how does that affect young learners' understanding of place, memory and identity?*

To answer these questions, I first produced lines by collecting first-person POV frames to reconstruct movement from the corpus which I then linked to video content, transcripts and field memos. Lines varied according to the Google Earth configuration they were produced from meaning one type of line could be extracted from Google Earth in VR which could not be extracted on the desktop due to their visual differences. After producing lines, I could compare across Google Earth contexts and look for differences that aligned with temporal considerations that I could then code for thematic content.

Most notably, I produced lines of learning via the visual frames that created the spatial environment from the perspective of youth. Based upon the composition of individual frames, I could further microanalyze its contents for contextual details that supported the learners POV.

I used a rhythmanalysis (Lefebvre, 2017) lens to describe rhythmic patterns of learner interactions which I linked to locations of temporal interest. For example, in the simulated VR environment, youth produced fluid, whimiscal-like lines because the environment enabled them to move in such a way it simulated flying. By describing the quality of lines rhythmically, I was able to describe differences among environments that would not otherwise be apparent if attending solely to location of interest and talk. Together, these lines create what I call *chronopaths*, or temporal units of analysis that contextualize time and space in the spirit of *chronotopes* (Bakhtin, 1981). I coded chronopaths according to temporal interactions (past, present, or future (speculative)) to indicate how movement through the digital environment was organizing youth's temporal engagement. These codes were further refined to reveal alignments between youth's patterns of movement and their encounters with time embedded in the visual qualities of the Google Earth environment as it impacted their thinking about history and place.

Tracing lines, visualizing data

While tracing youth's digital lines, I noted the places of interest that youth focused on by noting where youth spent time looking, pointing, or talking about. As I attempted to trace through lines across Google Earth configurations, differences in methods of engagement made it necessary to find different methods of producing lines for analysis. I identified three types of Google Earth environments and three corresponding methods of analysis (Figure 1) both accessible in VR and the desktop. To produce lines of movement using first-person POV Google Earth data, I used the structure-for-motion tool, ColMap. By uploading VR data, ColMap was able to plot out the direction of the camera and its trajectory for analysis. Street-view data occurred in both VR and on the desktop and could not be analyzed by ColMap. Instead, I manually traced through Street View lines in Google Maps. Over Zoom, youth were observed navigating from an aerial perspective and then dropping into Street View. These lines were far more difficult to

produce, so I instead systematically recorded first-person POV frames. Layered atop one another, these frames indicate the material engagement of youth while circling in on an area of interest (Figure 1).

Google Earth Configurations

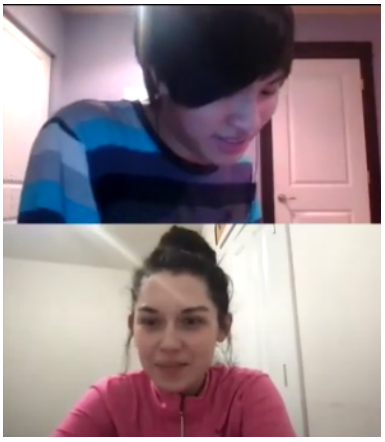
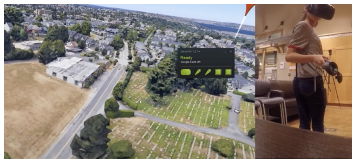
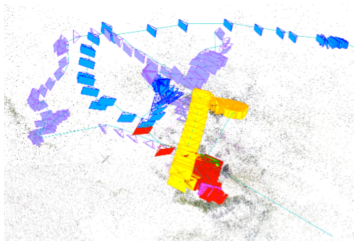
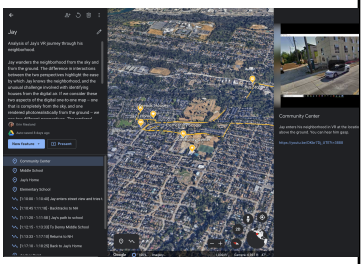
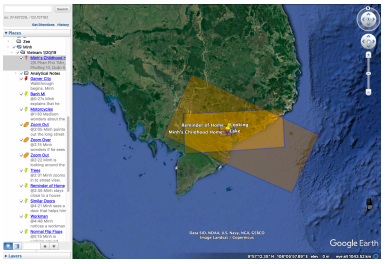
	VR Above Ground	VR Street View	Desktop
Digital			
Analog			
Analog & Digital			
Line Production	 ColMap	 Google Earth Web	 Google Earth Pro

Figure 1: Google Earth first-person perspectives analyzed to produce chronopaths through relevant analytic methods: ColMap motion extraction for above-ground data, manual plotting of Street View for Google Earth in desktop and VR, and frame mapping desktop data indexed in Google Earth Pro.

VR data and ColMap lines

To analyze movements in the "flying" data, I used ColMap (Fisher et al., 2021) to extract patterns of motion from screen recordings. The data produced through ColMap could only be used while youth were flying through the air because of the way the tool uses structure for motion to infer distance through video. I used ColMap to analyze Jay's video which required extracting video frames, or images, from the video. Video extraction was set to seven frames/sec (7 f/s) so that 100 frames in the data is equal to roughly 15 seconds of Jay's movement and interaction. Altogether, 2146 frames were processed by ColMap to create five minutes of Jay's chronopath. The ColMap-produced lines (Figure 2) highlight both Jay's fluidity and path of travel, as well as his perspective. Figure 2 illustrates Jay's first few minutes in Google Earth VR extracted from the video frames of Jay's recording. The point of the pyramid represents the approximate location of the camera in space, while the rectangle represents the image that was used to calculate Jay's position, and ColMap's estimation of where Jay was looking at different points of time. The purpose of using this method was not to recreate accurate models of a city using robots, which is what ColMap's original purpose is. Rather, this tool was used to demonstrate Jay's immersive and embodied engagement made available to Jay and the other youth participants who explored Google Earth VR.

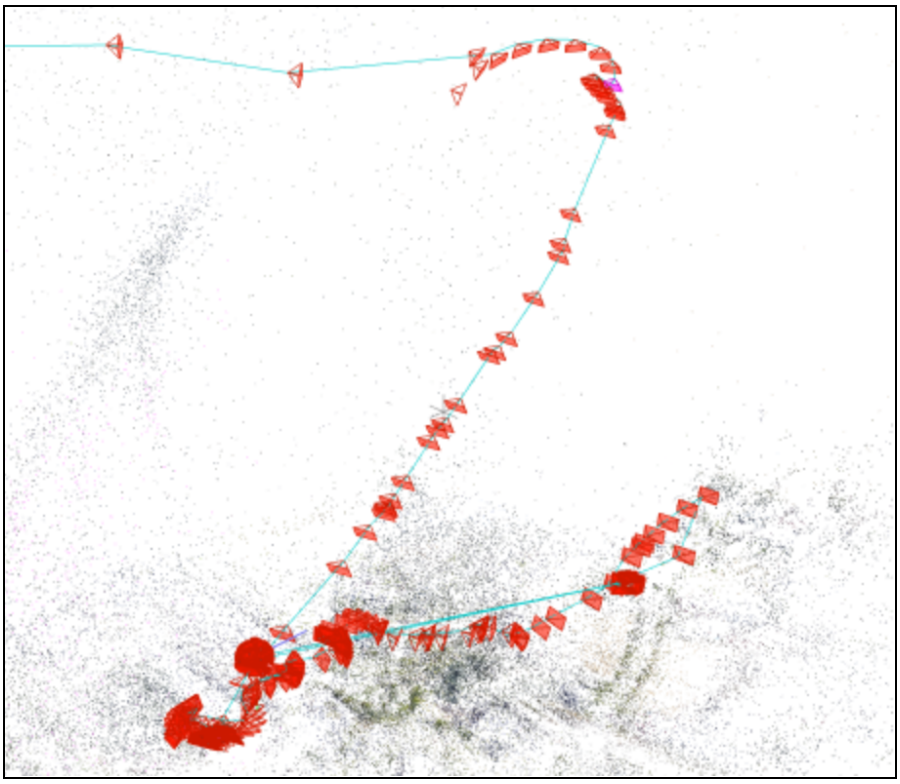


Figure 2. A section of Jay's chronopath depicted in ColMap data.

Street View data lines

Throughout the data youth regularly engaged in street-level explorations which could not be automatically linked to a mapping program. For this data, I identified locations in Google maps where I could then manually trace through trajectories.

Desktop Google Earth lines

ColMap produced lines using data from Google Earth by breaking video into a series of frames recorded from participants' screens. These frames include the area of Google Earth that youth were viewing from their POV. I used a similar technique by following youth's coordinates and replicating frames (Appendix A) which I recorded in Google Earth. As youth moved through Google Earth by zooming in and out, frames grew and shrunk. I overlayed these frames to gain a sense of aerial height and contextual information provided by Google Earth. Orange overlays (Figure 1) provided information about areas of

focus, while linked time-stamps to Street View explorations provided a less fluid, but no less useful trajectory of analysis to compare across patterns of learning interactions.

First-person points-of-view

In the data, it was evident that VR removed participants from third-person cinematic encounters and placed them into a first-person cinematic POV. Jay's video was solely from his perspective and reflected his gaze and interest which we could all view from the sidelines. Over Zoom, the first-person perspective was still there but "windowed," that is offered via the perspective of the screen. I produced lines that reflected the sensory differences between immersion and desktop which affected youth's patterns of movement and engagement. Researchers like Sarah Pink (2011, 2015) have argued that the potentialities of communicating and learning through digital photography depend on the materiality of the technology. She suggests that action cameras record lines of human movement that are (quoting Tim Ingold) "assembled from information obtained from numerous fixed locations" (2010, p. 122), thereby enabling a focus on the sensorality of a place (2011, p. 51). The digital environment then has control over the VR participant's experience of time by determining how far and how fast the body is able to "move." I found that by linking the camera to embodied experience, the digital environment can enable the same kinds of narrative tools employed by filmmakers. The youth in this study appeared to "fly" long distances, teleport, raise themselves almost into outer space and then drop down into street level as part of their place learning experience. Removed from the physically immersive experience of VR, participants' engagement with Google Earth was strikingly different seated at the desktop; these differences are evident through the linear fluidity of frames that provided their first-person POV.

Frames

Changes among cinematic frames indicated movement, while overlapping frames indicated interest. With each series of frames that created lines of learning, I coded according to interest. Fewer frames equaled less digital movement, and more interest. Frames created *chronopaths* through the digital environment

which provided me with insight into learners' digital place experience as it "emerges on the fly, in the flow of actual activity, and from the perspective of the actor" Lahlou (2011, p. 615 as cited in Pink, 2015). Because themes of time travel emerged early on in the data, I noted differences in temporal observations and narrations that accompanied frame interactions with Google Earth.

Chronopaths

Because this study is mainly concerned with embodied patterns of movement in cinematic environments and how differences in engagement contribute to temporal understanding, I found Bakhtin's concept of the chronotope to be an especially useful analytic term when considering interactions in the digital environment. Bakhtin's conception of the *choronotope* speaks to the underlying connection between time and space expressed in literature (1981). As an analytical device, the chronotope assists in breaking down the complexity of narrative and memory where predecessors, contemporaries, and successors are continually co-creating meaning (Goodwin, 2018; Schutz, 1967). Goodwin argues that material forms of communication continue to interact from the past through predecessors, in order to make meaning in the present with our contemporaries, as a way to influence future successors. By visually tracing learners' paths and applying the concept of the chronotope to moments of interaction and engagement, I present a new unit of analysis I call the *chronopath.*

Rhythmanalysis to evaluate and describe patterns of movement

Part of my analytical methods were derived from my desire to articulate differences in flows of movement through digital geographies. I noticed that material differences in Google Earth resulted in different line patterns. To describe these differences, I adopted Henri Lefebvre's conception of rhythmanalysis, a kind of analysis that uses rhythm to reunite qualitative and quantitative elements. "Rhythm appears as regulated time, governed by rational laws, but in contact with what is least rational in human being: the lived, the carnal, the body." These rhythms "superimpose themselves on the multiple **natural** rhythms of the body" (Lefebvre, 2017, p. 8), emphasis in original). Lefebvre looks to repetition and difference as a

way to further describe the qualities of rhythm which I found useful when looking specifically at temporality. Likewise, Deleuze emphasizes the role of repetition as playing a key role in our collective understanding of time. It is only when we can repeat an idea – whether it be in song or through visual repetition – that we are able to create temporal meaning by comparing present encounters of past experiences (Deleuze, 1994). By looking at the rhythm of lines created by young learners through their embodied engagement with the digital environment, the agentic qualities of the digital environment began to surface. For example, the aerial view in Google Earth VR provided a visually rich immersive experience for youth to soar above the environment visualized through whimsical measures (lines) punctuated by sparse beats indicating quick movements through the digital environment. Compared to the stuttered paths depicted through lines that Minh create via the desktop rendition of Google Earth, these choppy measures signaled less freedom and joy.

Summary of Findings: *chrono-cruising*, *chrono-walking*, and *chrono-dropping*

I observed three main patterns of engagement with Google Earth by tracing through interactions along lines of engagement that I call chronopaths. These chronopaths, are based upon the concept of the chronotope as a temporal and contextual unit of analysis (Bakhtin, 1981), and describe how youth explored place postdigitally; that is, how they used the affordances of the digital environment to enable different rhythms of movement to surface understanding of place and memory.

I identified three types of chronopaths that emerged by tracing and then comparing lines of learners' movements through different material configurations of Google Earth: *chrono-cruising*, *chrono-walking*, and *chrono-dropping*. I identified chrono-cruising lines via lines that were fluid and whimsical in pattern and shape. The frames that produced the lines stretched out as youth traveled faster, and bunched up as they stopped to observe and interact with something interesting in the environment. Youth produced these lines as they "flew" through the simulated Google Earth environment. I observed chrono-cruising mainly in VR, and rarely on the desktop in Google Earth. As a "flying" activity, youth spoke of their digital place encounters in the present tense, indicating a sense of presence. I observed

youth chrono-walking in Street View. Place at street level, youth clicked through connected panoramic photospheres that created a sensation of walking through the photorealistic Google Earth environment on both the desktop and in VR. Youth tended to spend more time chrono-cruising in VR and chrono-walking on the desktop. Youth engaged in chrono-dropping, or looking for places of interest from an aerial view and then "dropping" into Street View. This pattern of movement occurred in both VR and desktop versions of Google Earth; however, youth were observed chrono-dropping repeatedly in the desktop environment.

In the first section, I describe and summarize examples of chronopaths and their temporal indications. In the second part, I highlight sociomaterial differences observed among the three types which I then compare to similar Google Earth activities conducted in the absence of chronopaths due to a lack of visual information.

Learning along postdigital lines: Encounters with temporality

Chronopaths depicted different visual patterns that reflected youth's movements. Differences in the digital environment aligned to different temporal encounters with place. Some configurations were more conducive to being in the present, while other paths reflected learners' thinking about the past and memory reconciliation. In VR, two distinct chronopaths emerged: c*hrono-cruising* and *chrono-walking*. Chrono-cruising was an activity young learners often engaged in where they would spend a few minutes at a time "flying" around the digital world while looking for something of interest, or just enjoying the immersive sensation of traveling high above the digital ground. *Chrono-walking* only happened when learners entered Street View at ground-level. On the desktop, learners were observed *chrono-dropping*, or moving the world around and "dropping" down into an area of interest spotted from above into street level where they could click through linked panoramic images provided sometimes by Google Earth, sometimes by users, and sometimes by paid sponsorship.

Figure 3. A STUDIO youth looks for her brother in the window of her house as it appears in Google Earth.

Repetition and Tempo

Jay's interactions in VR closely mirror the patterns of the other youth in this study. As Jay entered the Google Earth virtual environment (Figure 4a), he audibly gasps and then orients himself over the community *anchor point* (STUDIO's lab shown in Figure 4b), where he pauses before lowering himself down to his home (Figures 4c-g). The data in Figure 4 reflects Jay's second journey in Google Earth which is reflected in the tempo he takes up through simulated movement movement. VR participants in Google Earth are able to control the speed, or tempo of digital travel and Jay's quick orientation downwards is illustrated in Figure 4a where he begins the chronopath towards the top, and lowers himself in a "swooping" measure that stops just above his house.

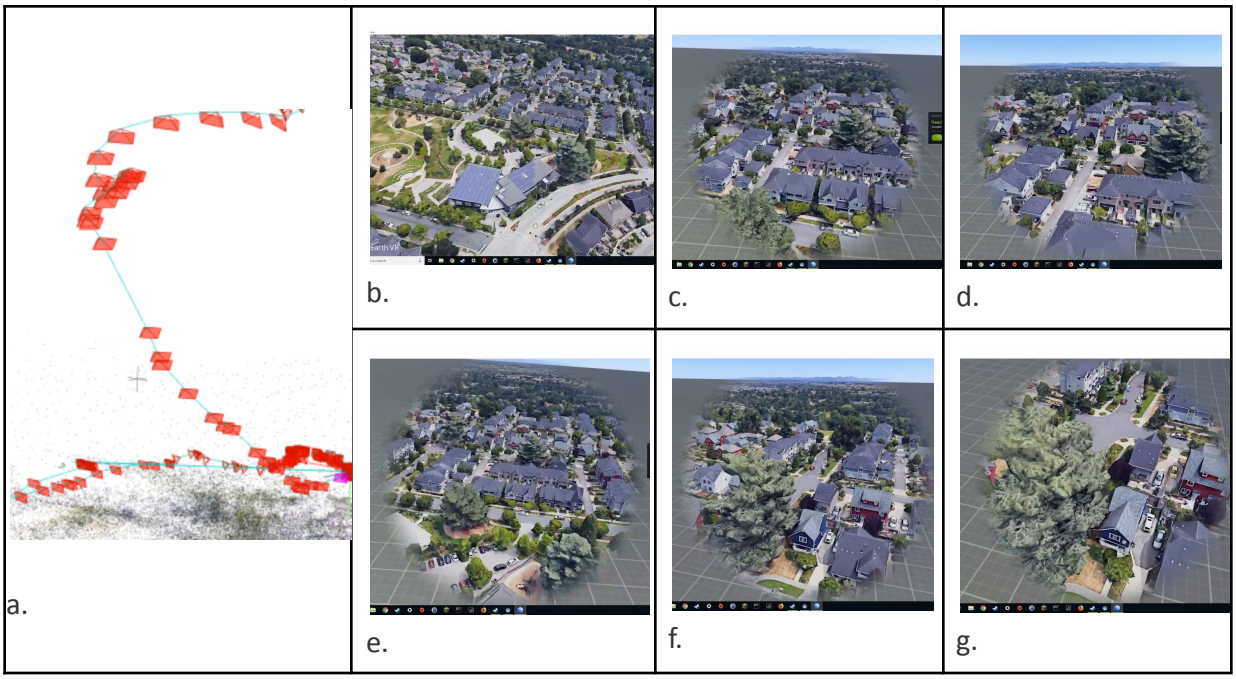


Figure 4. ColMap data (a) shows Jay's path and view (b - g) as he encroaches upon his blue house.

When he reaches his house, he says nothing but clicks repeatedly, likely to see if this would bring him closer to the ground. The above-ground simulator in Google Earth forces a perspective that appears to be 50 feet off of the ground, creating the illusion of feeling like a giant looking down at a "dollhouse" environment. The participants in this study regularly exclaimed how "cute" their home looked in VR and that they felt like a "giant." Google Earth's model of the world created a cinematic simulacrum (Baudrillard, 1999) or the analog world that was more hyperreal than analog real. Through the VR headset, the environment of Google Earth set the rhythm and tempo that becomes the embodied, perceptual sensation of clearing large distances in a short amount of time. In VR, participants easily recognized the controllers in their hands and the movement of their head reflected in the digital environment. With the ability to fly slowly, quickly, or teleport simply by pointing their controller and clicking a button, learners were elated to have been granted access to a version of their neighborhood that was eternally sunny, warm and free to explore. Out of the eighteen participants observed, only the youth who had personal connections to locations outside the neighborhood chose to explore them. The others

stuck close to home and enjoyed the illusion of soaring above familiar buildings in the comfort of the lab or experimenting with tempo and distance – activities I refer to as chrono-cruising.

Chrono-cruising

Chrono-cruising can be enacted at a variety of speeds by the participant according to their comfort level and desired pace. Altitude contributes to speed as the higher the VR participant rises in Google Earth, the faster they are able to clear large distances. The higher youth rose into the air, the faster and further they were able to travel. Jay preferred to stay closer to the ground, although periodically, Jay would veer off in an unexpected direction and then effortlessly ping-pong among his favorite local and familiar places. At the elementary school, Jay excitedly pointed at and clicked the play equipment as if he could virtually play on it like it was an immersive video game. Other youth experimented with cruising by raising themselves above the digital ground until only a thin layer of atmosphere was visible. Audible gasps would follow. One youth exclaimed "Oh god! How do I get down?"

As the tempo of travel quickened for participants, frames lessened in sharpness. Unable to render the entire environment during high-speed movement, Google Earth would shrink the field of vision into a rabbit hole view that lessened motion sickness and eased the strain on the technology and connection as it struggled to process huge amounts of data on the fly. While all the youth observed in this study seemed to enjoy chrono-cruising, few seemed as interested in following the roads as Jay. Jay talked a lot about the routes he walked in the neighborhood, and according to his baseline map created at the beginning of the session, was granted a lot of mobile autonomy and independence to walk to his somewhat distant school, and take the bus to his friends' houses. While chrono-cruising, Jay's tempo was quick and intentional as he would lower himself slightly above the tree line and fluidly follow windy paths. I observed Jay following this behavior repeatedly, tracing through road after road, and then back again as if he was trying to learn the city via aerial view. The measure provided by Google Earth could be described as fluid and whimsical as echoed in the paths that young learners traveled (Figure 4a).

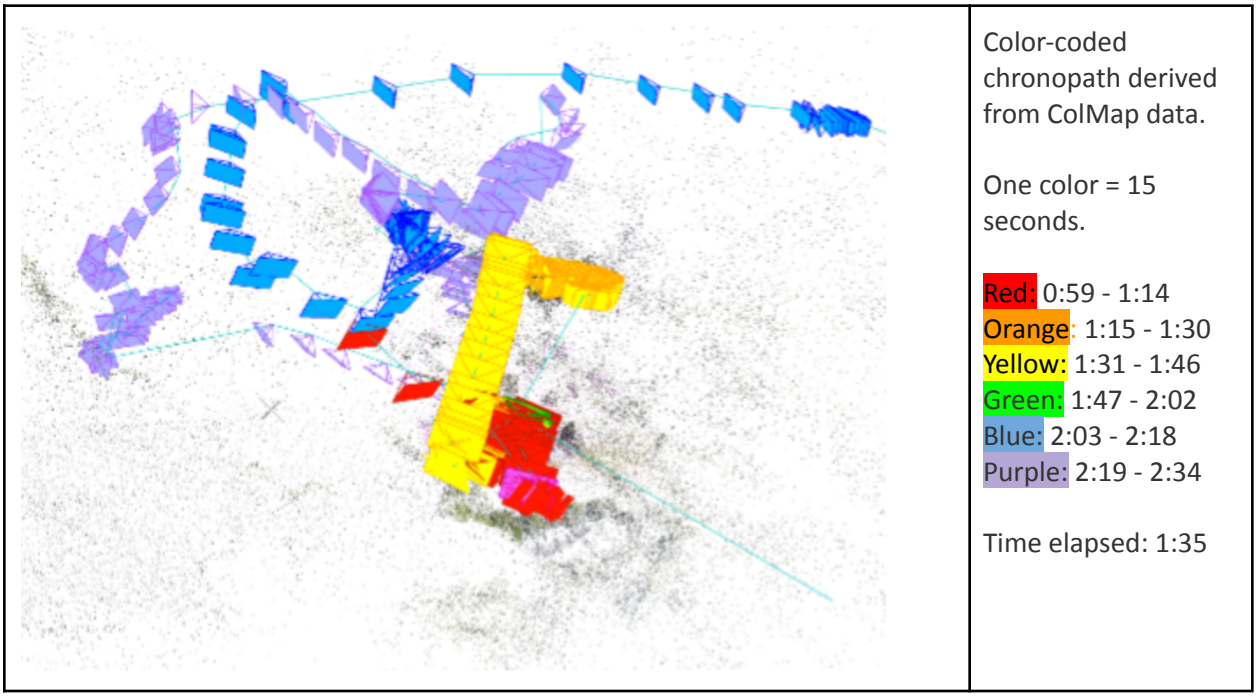


Figure 5. Jay's path through Google Earth VR from 0:59 to 2:34. Frames are color-coded according to elapsed time, each color is equivalent to 15 seconds of travel.

In Figure 5, Jay's chronopath is color-coded according to time beginning with red. The direction of motion can be inferred by the direction of frame; however, the frame depicts where Jay was looking, not necessarily where he was moving. Clusters of frames illustrate where Jay stopped for a bit to look around and focus on an area of interest. These frames create beats that change less and less, thus creating a temporal impression of the environment. I noted where dense clusters of frames occurred, and picked out corresponding images to analyze indicated by the magenta frame located in Figure 5 which highlights where Jay started in the chronopath above and is detailed in Figure 6. I colored every 100 frames at 7 frames per second to indicate roughly 15 seconds of movement recorded in the immersive digital environment. Through this analysis I inferred the rhythm and tempo of Jay's chronopath as I tracked his first-person cinematic perspective. Minute 1:15 to 1:30 (highlighted in orange but obscured) depicts Jay's interest in his community play field. The clustering of red and orange frames breaks at yellow, where Jay wanders to the other side of the field before quickly returning to the play area (mostly obscured in green). The video record at this point shows Jay experimenting with hurling himself backwards – a move the

ColMap tool has likely never encountered in the analog-recorded video it was programmed to analyze. ColMap render's Jay's return to the area in blue starting in the upper right hand corner, and quickly swooping back into the environment.

Summary of temporal engagement in chrono-cruising: In the present

Chrono-cruising chronopaths highlight the fluid freedom that Jay was able to explore his neighborhood. The tempo of chrono-cruising paths expressed the fluidity of Google Earth exploration, and the preponderance of frames focused on playfields and schoolyards, coupled with increased clicks and spontaneous movements further support the ways that Jay felt he was present in the world. However, the imagery that Google Earth renders is of a cartoon-like environment frozen in time and absent of people.

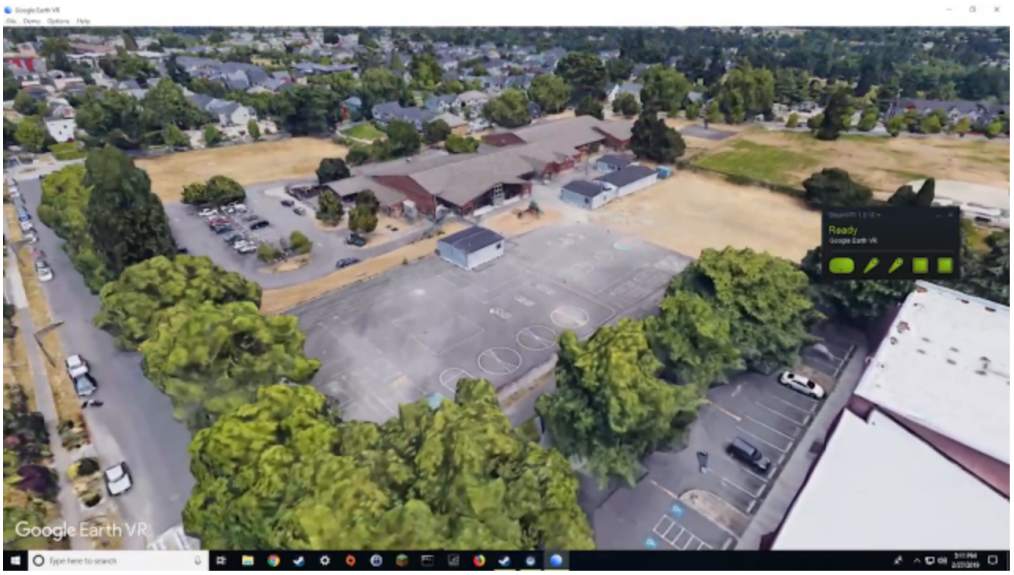


Figure 6. Frame # 432 Jay looks down upon his elementary school and community center.

Chrono-dropping

Between desktop and VR interactions, I only observed chrono-cruising for sustained periods of time (> 1 minute) in VR. On the desktop window, youth would fly in 3D mode for only a few seconds, experiment with spinning the globe, but overall seemed more interested in finding an area of interest to explore through Street View. Of the Google Earth VR data, only 11% of the almost six hours of data show the

youth exploring Street View, while screen recordings of youth engaged on the desktop were focused on seeking the blue lines that indicated Street View availability. These desktop chronopaths of movement through Google Earth involved very little chrono-*cruising* and far more *seeking* and *probing* emphasizing a far more utilitarian usage of the digital environment.

I observed youth routinely chrono-dropping into Google Earth on the desktop, taking a few steps, and then repeating the behavior. Rather than exploring the immersive digital world in VR, youth would click on the globe and rotate it, then zoom in, identify an area rendered in Street View and then "drop" into Street View. After walking a few steps in Street View, youth would return to the globe and look down again. The chronopaths created on the desktop consisted of frames that would grow and shrink depending upon the height. The learner is not immersed in the digital world as they are in VR, and so the desktop becomes more like a menu to select an area of interest and sample it in Street View. The chronopaths that learners produced in Street View consisted of a series of frames peppered with comparatively small bits of Street View data as they attempted to gain a "sense" of place. In Figure 7, pins indicate where Minh explored Vietnam in Street View – where he took short chrono-walks. Orange boxes indicate Minh's rhythm and tempo as he zoomed in and out, left and right over the course of 10 minutes of exploring Vietnam in an attempt to locate his childhood home. Eventually Minh's mother comes home and she is able to tell Minh where he lived as a small child ten years earlier. The data in Figure 7 illustrates Minh's chronopath as he looked for familiar objects from his memory (green trees, busy streets, metal doors) from above (Figure 7b and 7c) to explore from street level (Figure 7a and 7d).

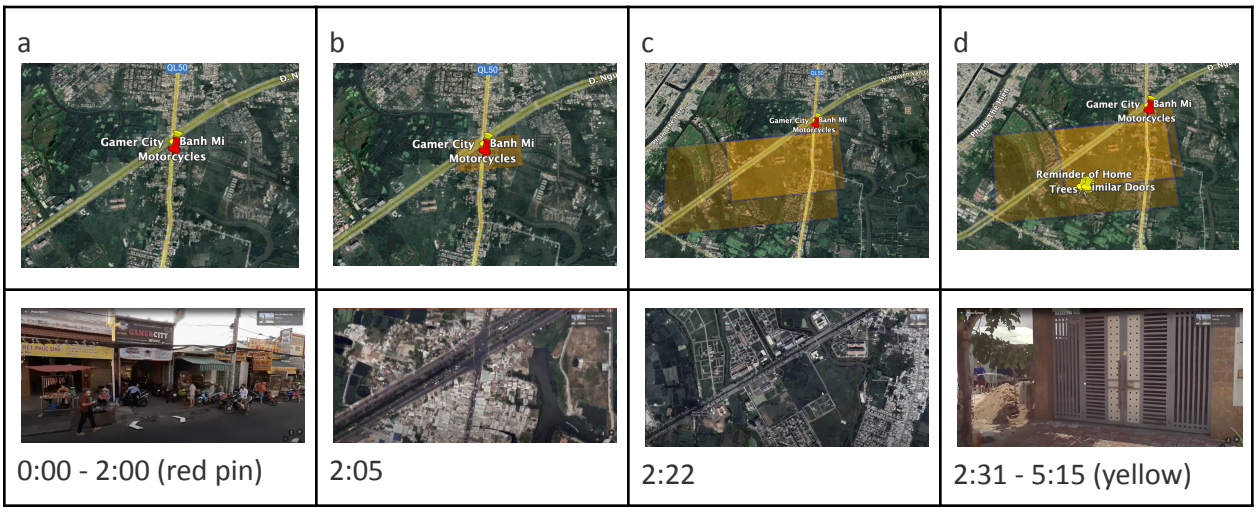


Figure 7. Frames of interest (a-d top) and corresponding Google Earth imagery (a-d bottom). Frames a and d illustrate chrono-drops that led to chrono-walks.

Minh repeatedly engaged in chrono-dropping throughout his exploration of Vietnam. With each drop into Street View, he would see a few more things that would elicit memories of his time in Vietnam. Panoramic images of busy streets filled with pedestrians and motorcycles cinematically communicated an impression of Vietnam that Minh recognized, and his mentor, Em, could begin to understand. In Figure 7d, the yellow pins indicate where Minh shows Em doors that are completely unlike anything he remembers from his childhood. Minh then looks around and sees all the trees and remembers the greenery. "It looks hot" Em remarks and Minh mentions he had never worn shoes before coming to the Northwest at age of five. Comparatively, the Street View paths depict a much smaller distance than the frames of interest Minh moves through as he zooms in and out of Google Earth (Figure 8).

Frames rotated after Minh would drop down into Street View and then return. With each rotation, the orientation of the map would temporarily cause Minh to lose track of Ho Chi Minh city and his area of interest. The twists, sizes, and overlaps of frames show changes in relative altitude and orientation over time which when connected together, create Minh's chronopath. Each drop produces a comparatively tiny on-the-ground path that features cinematic street-level frames of imagery that remind Minh of his time in Vietnam as a child. These frames are incompatible with one another because of their disparate distance

and lack of fluidity when moving from one perspective to another. Google Earth on the desktop lifts the viewer into a cartographic mode that flattens the landscape below. Completely abstracted, this view lacks the aerial immersion of VR. Furthermore, Ho Chi Minh city was not rendered into a 3D model like the environs of Minh's American neighborhood. Street View provided the only entry point into a location-centered first-person perspective of the city.

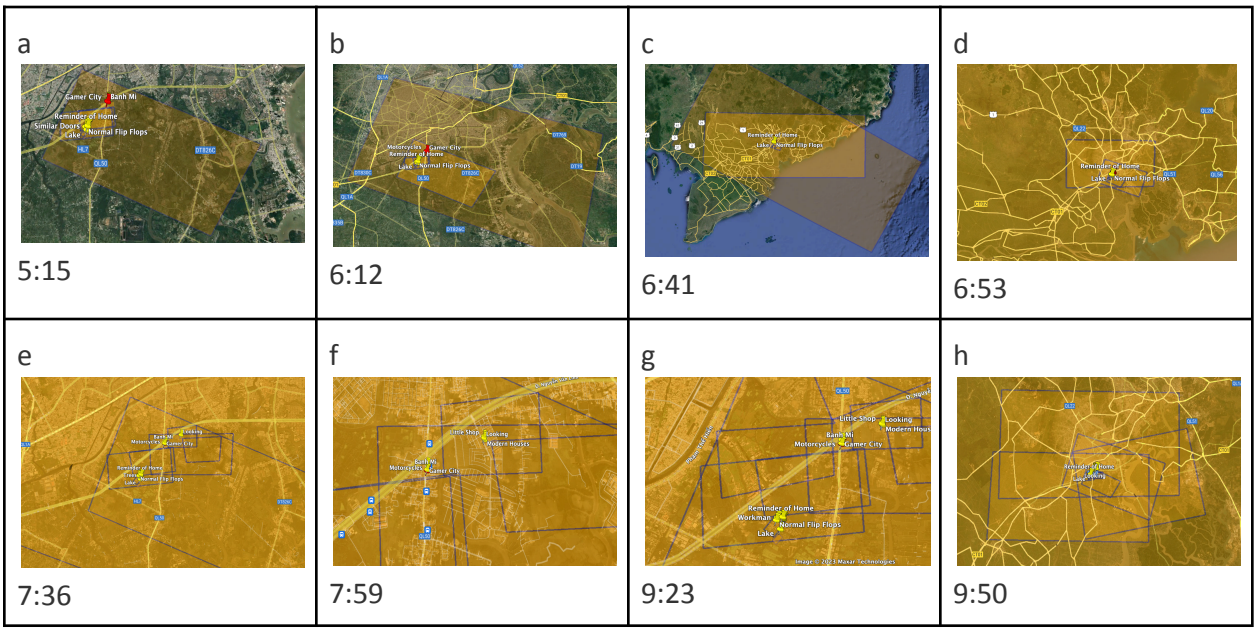


Figure 8. Minh's frames of interest charted over time. Changes in frames over time represent altitude and direction. Larger frames indicate a larger area of interest (and higher altitude).

Minh's rhythmic and stuttered chrono-dropping movements through Google Earth on the desktop sharply contrasted with the fluid chrono-cruising paths that participants produced while flying above the simulated neighborhood in VR. Once Minh figured out where his house was, he spent the remainder of the time in Street View zooming in on the details of his apartment (Figure 8).

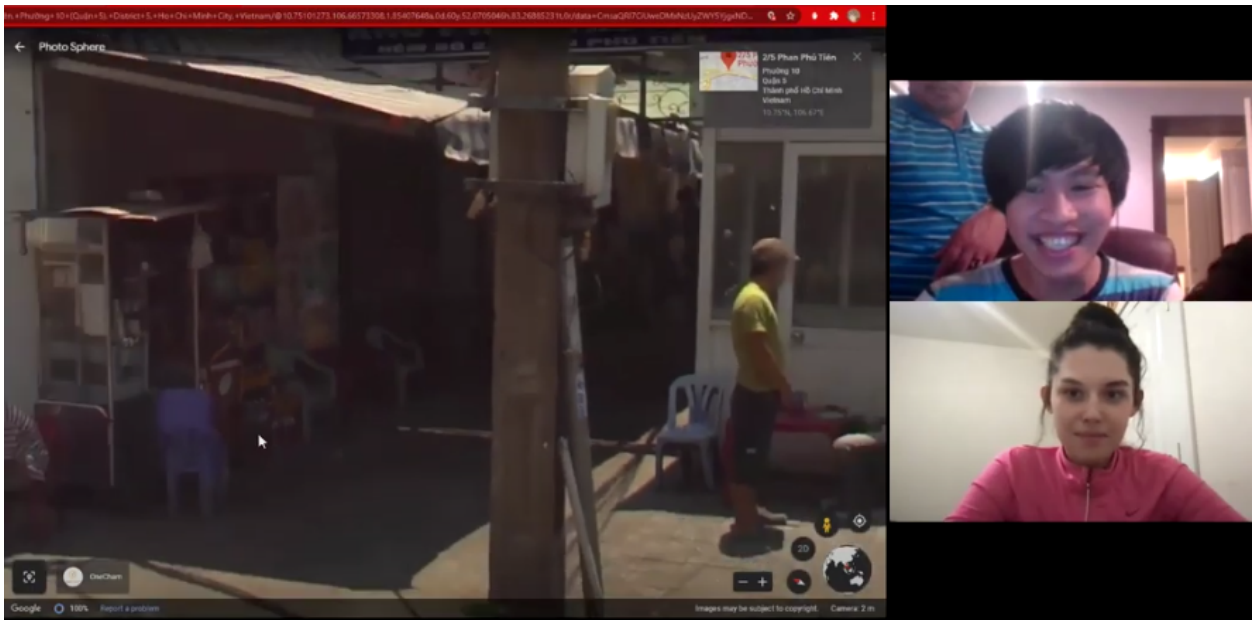


Figure 9. Minh's parents tell him about his life in Vietnam while his mentor Em observes after chrono-dropping into Street View.

Once Minh's parents arrived towards the end of the 45 minute session, Minh could begin to reconcile his memories against the imagery provided by Google Earth's Street View. "It looks so pretty now!" Minh's mother exclaims. "It used to be so ugly!" Minh's family repeatedly talked about the Street View imagery in the present tense, regularly comparing their memory to Google Earth's more recent imagery. "I remember the farm in the back" Minh tells his parents and gestures towards the small passageway leading off the street. Surprised, Em asks about the farm. "There were chickens and goats…and bananas." Minh's mom continues to reminisce about their family's life in Vietnam in Vietnamese (translated later by Minh), and repeatedly mentioned how much "prettier" the neighborhood looked now. Based upon the layers of overlapping frames that produced Minh's chronopath, Minh appears to have remembered his home being a bit further south and in a greener area than he remembered (Figure 10). It is possible that changes in urban density led Minh to believe that he lived in the south where the greenery is denser. Or that Minh's memory was biased towards the greenery he paid attention to as a small child. Regardless, the location-based cinematic imagery provided by Google Earth contributed to Minh's memory and identity through a complex "we-relationship" (Schutz, 1965) formed through him, his

parents, and Google Earth. As noted by Goodwin (2018) elaborates on Schutz' theory, predecessors are present in the objects learners interact with to organize and make sense of their own experience. The co-presence of contemporaries, in Minh's case his parents, contribute to Minh's newly reconciled memories that were taken from the interactive and cinematic imagery offered through Google Earth.

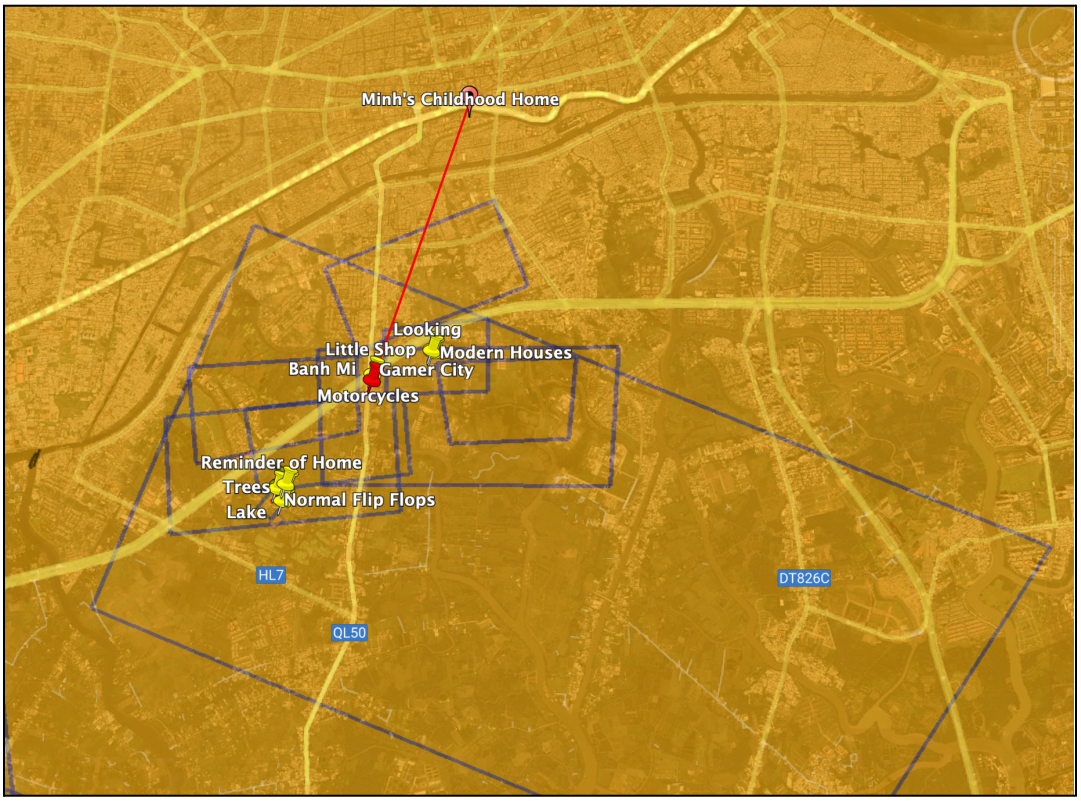


Figure 10. Frames of interest overlapping an area of Ho Chi Minh city located approximately 2.5 miles from Minh's area of interest.

Summary of temporal engagement in chrono-dropping: linking past to present

As Minh produced his chronopath, he would point out familiar imagery and talk about his time living in Vietnam during chrono drops. While the imagery was not specifically of his home, neighborhood, or family, it was the shared "sense" of the place that Minh responded to through the cinematic imagery produced by looking, zooming, and looking elsewhere. Unlike the rendered above-ground VR data, ColMap is unable to extract motion from Street View, so I could only highlight objects and subjects of

interest in my data, and note when Minh zoomed in on items. Despite these limitations, I was able to trace out Street View paths which flow far less dynamically than the frame-based chronopaths I extracted through other types of data. The tempo of Street View is far slower and more linear. Participants could travel up and down the street, but generally not off of it – although zooming into an area off of the street conveyed the illusion of walking off-path. On the desktop, chrono-dropping was the main activity youth engaged in as they worked with mentors to complete their geobiographies. In VR, chrono-dropping was not part of the tempo of exploration; rather it was a sustained change of rhythm. Once participants navigated into Street View, they would stay and look around for an average of one minute before returning to above-ground cruising. In contrast, Minh rhythmically searched overhead and then repeatedly dropped in and out of Street View as he looked for interesting and familiar places that conveyed his analog memory of Vietnam.

Chrono-walking

Minh's chrono-walks in desktop Street View reflected the average length of time that participants engaged in VR chrono-walks before departing to another location: around one minute. One notable outlier in the data is Jay whose above-ground VR travels reflect those of the other youth in this study while his on-the-ground chronopath is far longer (8.5 minutes) than anyone else's in the study. One way Jay is unique is that he walked the entirety of his neighborhood unlike his friends who either stuck to the immediate environment of the neighborhood, or who were given rides by their parents to the locations they frequented. Jay reportedly took the bus and/or walked everywhere he wanted to go and so when Jay had a chance to walk in Google Earth in Street View, he chrono-walked a path that was very similar to his above-ground path (Figure 11). In Figure 11, the rainbow-colored frames indicate four of the main locations Jay focused on: his house (1), the middle school (3), the school (4) and community center located on the other side of the school (5). Image 2 of Figure 11 displays the orange chronopath that led down the road to his school (3). Jay repeats this well-worn path both in aerial view and in Street View,

appearing to look for difference. Jay's methodical behavior seems to reflect his desire to identify differences between this novel VR walk with his routine analog walks.

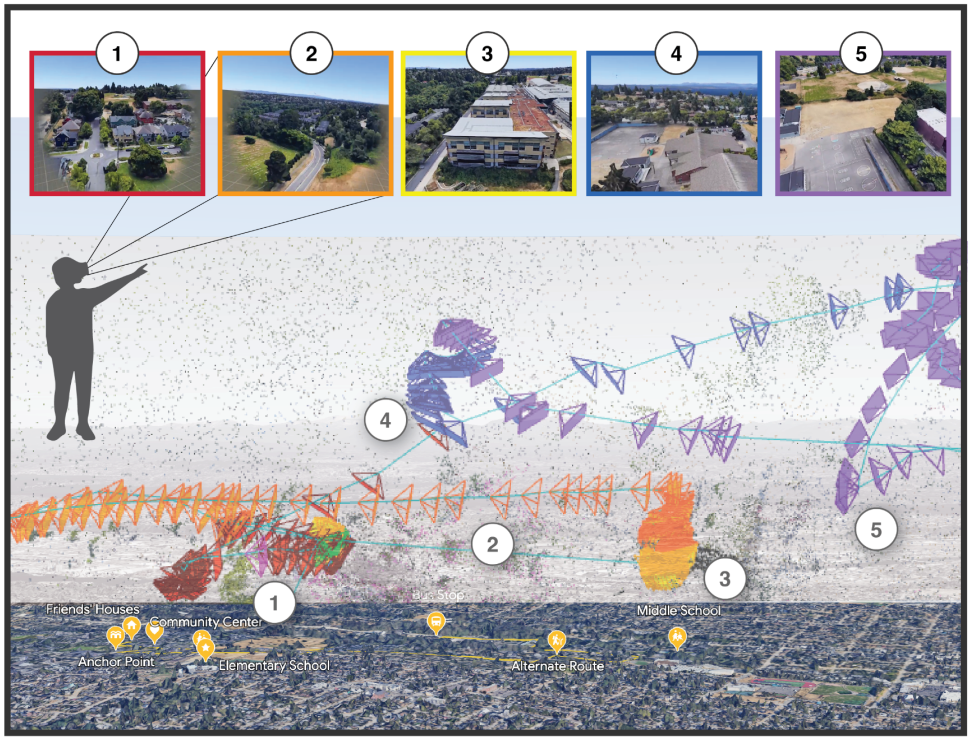


Figure 11. Jay's above-ground VR flight depicted over his street walk path.

The area in the lower part of Figure 11 depicts Jay's street walk path and areas of interest as indicated in yellow. The two paths highlight differences in tempo and rhythm as well as areas of interest only visible from the street like the bus stop and alternate route that Jay stumbled upon during his chrono-walk. During his chrono-walk, Jay explores the same number of areas (8), yet over a greater amount of time (8.5 minutes versus 5.5) shown in Table 1.

Table 1

Jay's aerial VR travels compared to Street View

Time (m:ss)	Above-Ground VR	Street View VR	Observations
0:20	Jay arrives in his neighborhood near the community anchor point	Arrives in an area near his house, clicks to move. Al asks "Hey, where you going?" and Jay answers "I'm going to my old school"	Disoriented in the air, compared to goal-oriented on the ground
0:40	Spins around and points to a set of buildings, including the community 1. **anchor point**	Arrives at 1.**elementary school**, clicks gate	Pointing to the ground versus quickly finding school and trying to interact with the environment.
1:00	Hovers over his 2. **home**	Arrives at 2.**anchor point**, then 3.**friends' houses**. Al asks how he would get home "through the field" he said, but traveled along the road, following the paths made by the google street car that filmed the area.	Jay began near the anchor point, but did not point out his friends' houses which were more recognizable from the ground.
1:20	Arrives at 3. **elementary school** and tries to "play" by clicking on the equipment	Travels down road to find way to school	Immediately looks for places where he used to play.
1:40	Pushes self backwards.	Transports self onto another street and becomes disoriented	Jay is disoriented when losing sight of the main road
2:00	Follows road to middle school he attends	Quickly finds 4.**bus stop.** We see the traffic and busy main highway where Jay is "walking."	Follows road after 2 minutes in both cases, later on the ground
2:20	4. Arrives at **middle school** and looks down at track	Al asks "do you know where you are?" Jay answers "yeah. I took the bus right here.I took the bus right here." Surprised Al asks, "you take the bus?" Jay clarifies, "no I take the school bus, I took the metro bus with my friend. I just wanted to ride with my friend" he tells Al.	On the ground, Jay talks about his day and points out places that have meaning
2:40	Passes by 5.**elementary "old school"**	Shows route through Home Depot parking lot	Forced to stay on the road, Jay can only describe his short cuts through the parking lot

3:00	Returns to 6.**community center**. "Now if I go this way, I can get to [my middle school]."	Continues walking to school.	Here is where Jay appears to be learning the novel pathways of the air where he's crossed by destinations several times.
3:20	Points to where he played at the **c**ommunity center. "I played here…and I played right here."	Arrives at 5.**middle school**	Jay traces his walking route all the way home, frame by frame
3:40	Experiments with flying in VR by clicking on the ground and pushing himself backwards	Still at middle school, Jay points while clicking the parking lot, points at the field and talks about playing basketball. "I play here"	Over three minutes in, Jay is more enamored with the novelty of hovering above his neighborhood in VR than in recounting experiences of his day-to-day life on the ground
4:00	Takes off headset to tell observers that he found his 7. **friend's house.** Points: "This is my friend's house!"	Begins an alternate route to demonstrate how he walks home. "Sometimes I go this way" he says after he turns off the street.	On the ground, Jay is able to relate his "daily round" with his mentor.
4:20	Jay holds the cursor in place and continues to point. Al asks "Do you visit your friend often?" He answers yes, and the screen jiggles because he is nodding.	Continues walking.	Al observes Jay both in the air and on the ground, but asks more questions while Jay is on the ground.
4:40	Follows the road	"	Jay tightly followed the road from the air through much different movements than in Street View.
5:00	Finds 8.**anchor point** to locate friend's house and then follows road.	Al: "How do you know which way to go?" J: "I just go straight"	At 5 minutes in the air and on the ground Al is relying upon visual cues to direct him. The anchor point continues to be a starting point to find places from the air, whereas Jay recognizes his route from the ground.
5:20	Assisted by researcher to switch to Street View	Continues walking.	At this point, Al has visited 6 points of interest from the air, and only 4 from the ground implying differences in the digital environment's expression of time.
5:40	SWITCHES TO Street View	Speculates whether it's summer in VR. Al: "Does that look like summer in Seattle?" J: "I don't know, maybe."	Jay appears to not be thinking much about the time of year compared to the present.

6:00		Proclaims it's four o'clock as he continues to walk down the street. Al: "What time do you think it is? J: "Four"	Jay would normally be walking home at 4.
6:20		Finds the field at the 6.**community center** where he plays	Jay repeatedly points out the community center's importance in his life.
6:40		Continues walking while Al asks Jay about another nearby park.	
7:00		Arrives back at the 7. **anchor point** where he recognizes people he knows captured in Street View. "Oooh, I know this guy!"	Faces are blurred out in Street View, but Jay recognizes the person crossing the street.
7:20		Takes off headset to point out the mutual acquaintance to someone in the room	Jay wants everyone to see that someone he knows is in Google Earth VR. He speaks in the present tense: "I *know* that guy"
7:40		Talking continues offscreen.	
8:00		"	
8:20		Places headset back on and arrives 8.**home** to his door being open. "Why is my door open?" Takes headset off and we hear "Why is my door open?" faintly repeated.	Jay asks this question in the present tense, as if he might walk to his home and see his open.

Jay's entire trip immersed in Google Earth lasted around 13.5 minutes, 5 of which was spent in the air in an entirely novel orientation to his neighborhood. Like the other youth in this study, Jay became excited at the sight of his house and playfield from above, and also like the other youth, he layered his everyday encounters with the neighborhood atop his virtual, cinematic Google Earth "predecessor" (Goodwin, 2018; Schutz, 1967). The beats and measures of Jay's in-the-air chronopaths are far more fluid and organic. Where the beats quicken, the measures shorten and reflect an increase of time. In Street View, tracing through frames is trickier and is instead marked by a pin and a corresponding time stamp (Figure 12, timestamps not shown). In Street View, frames are determined by panoramas that are evenly spaced. I observed Jay methodically and rhythmically clicking through the connecting panoramas as if simulating a walking pace, stopping periodically to look around. Visually, the path is comparatively rigid and straight

as Jay is forced into the same route that cars take. As he navigates Street View, he is not on the sidewalk but is in the middle of the street, placed into the perspective of a driver.

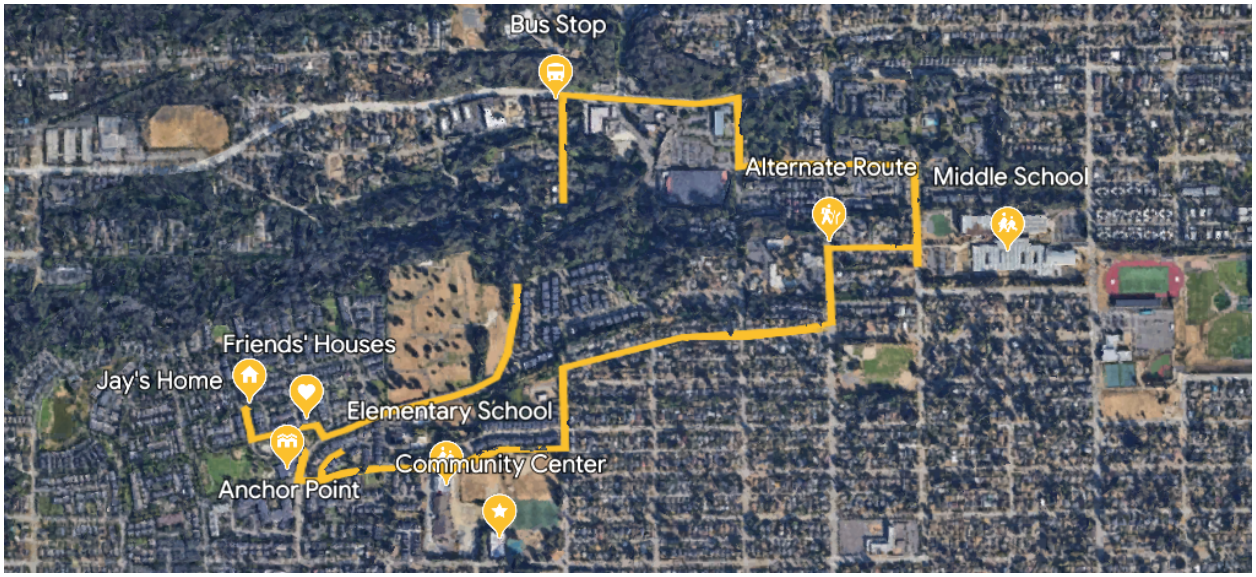


Figure 12. Jay's Street View route which begins near the elementary school and finishes at his home.

Temporality and materiality

Material differences among Google Earth configurations (Street View, desktop, etc.) chronopaths contributed to youth's temporal understanding. The slower and constrained tempo of VR opened up the opportunity for Jay to talk with his mentor, Al as he digitally strolled down the sidewalk. Jay is observed saying a few words while chrono-cruising in VR, but on the ground he talked continuously to his mentor, sharing his day, his friends, his shortcuts and places he liked to play with Al. Although Jay can't see Al with his headset on, he knows Al is there watching the monitor as he chrono-walks. Periodically he would take off his headset to make sure Al or some other friends in the room could see what he was talking about. This comparison in data shows a stark difference in rhythm, tempo, and temporal discourse between two VR encounters (Figure 11).

Time was a popular topic at Street View because of its photorealistic qualities. The panoramic images are mostly sunny and so Al asks what time of year Jay thinks it is (Table 1 at 5:40) and then asks

what time of day it might be. Jay seems uninterested in this speculative activity until he reaches his digital house and finds his door open. His tone is concerned as he sincerely inquires: “Why is my door open?” In the recording, you can see the visual effect of Jay removing his headset off as the image destabilizes and then lowers to the ground. The effect is similar to dropping a camera and watching the footage later on, leaving the viewer to wonder where the camera operator went and why. On the recording, Jay’s voice can be heard asking again in sincerity, “why is my door open?” Both in Vietnam and down the street, the discrepancies emerged: gas stations changed signs. Weather transformed from sunny to gray. In Vietnam, people were everywhere and they were all wearing masks. “Wait,” Em wondered aloud to Minh as they wandered the street, “is this before or after Covid?” The frozen people of Street View were far less frequently sighted in Jay’s neighborhood. Whenever youth in the study would run into a person captured on the street, they would try to figure out who it was despite their blurred faces. Above ground, no people were visible, but on the street youth would wave and say hello to strangers and speculative friends. Towards the end of the ten weeks, a few of our panoramic images were accidentally published into Google Earth’s VR world. One day, youth literally “bumped into” themselves and were overjoyed to see themselves rendered into the digital world. Researchers concerned with privacy were not overjoyed and quickly took the images down.

Summary of temporal engagement in chrono-walking: In the present recounting the past

Jay methodically paced through familiar areas while nostalgically sharing his experiences with his mentor. Similarly, Minh used Street View to show his mentor, Em, around as well. Whether immersed in VR, or viewed through a desktop screen, Street View elicited a similar effect: the desire to share one’s experience. It is the movement through the streets that placed youth in the present while alerting them of their past. Street View elicited temporal confusion among participants who were alerted to discrepancies in time conveyed through visual cues like mask wearing, and snapshots of open doors.

The Sociomateriality of the Cinematic

Visual renderings of analog places matter; different cinematic qualities and embodied engagements elicited different temporal patterns of learning in youth. In this next section, I look at the sociomaterial qualities of chronopaths as they relate to visual engagement and interaction.

Chrono-cruising versus chrono-walking lines

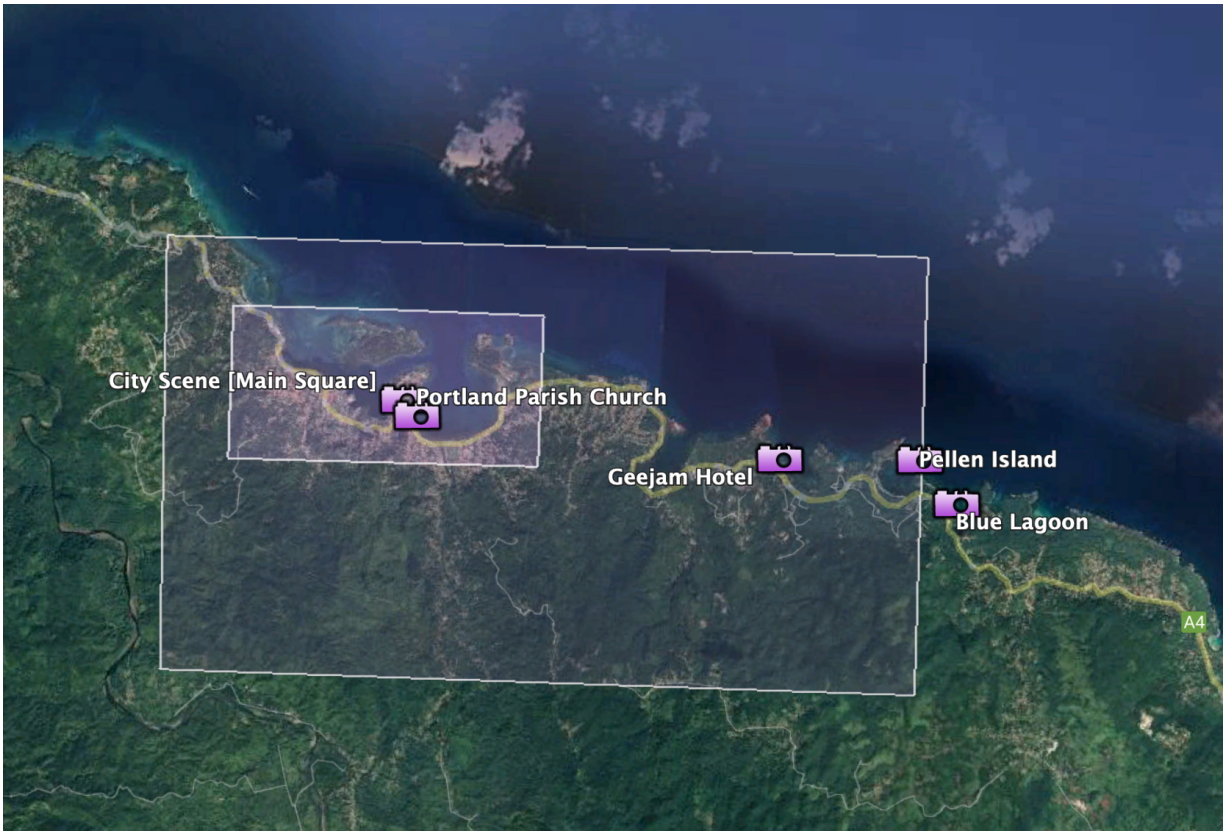
In the air and on the ground, Jay related his encounters to his lived experience and memories. Like the other participants in this study, his in-the-air encounter began with a bit of disorientation, followed by exclamations of recognition. The anchor point of the STUDIO lab became the orienting location that youth would regularly return to both in the air, and walking on the ground in the Street View. Google Earth in VR gave youth the opportunity to see familiar places from a perspective they had never seen before – to see their neighborhood in a new way. Jay's speech was similar to the kinds of exclamations other youth had of awe and intrigue over the feeling of soaring above their neighborhood. Their exclamations of recognition "that's my house!" or like Jay, "that's my friend's house!" highlight the aesthetically powerful novelty that Google Earth provides. On the ground in Street View, the imagery in Google Earth remains cinematic, but less novel in appearance. Clicking through linked panoramas, Jay's movement is limited to his gaze. He could zoom into places, but not to the same extent as the rendered model that enables participants to fly and cruise. Jay engaged in much more chronowalking than the other youth in this study. Whereas others would identify their house from the air, and drop down to explore in Street View for a few steps and a quick look around, overall participants enjoyed the novelty of flying and getting to see how their house was modeled in the VR world. "It looks like a Barbie house!" one participant exclaimed upon seeing her home. Jay, however, would only point out houses and places he could recognize from the air. He seemed especially interested in outdoor playfields where he was able to see areas of play from a different and novel vantage point (Figure 13).

Figure 13. The view of Jay's middle school playfield in VR versus its obscured location in Street View.

Jay and Minh's chronopaths demonstrate the ideal Google Earth experience: a fast connection with access to plentiful location-based visual resources that can be experienced immersively or at a desktop. Not everyone has access to cutting-edge technologies (although successful tech eventually becomes more accessible and affordable over time), which rightfully raises concern when considering the underlying inequities of postdigital place learning. More insidious, however, are the underlying limitations of representation. The youth featured in this study come from diverse and primarily refugee-based backgrounds which provided the impetus to include place, community and culture as an integral aspect of the underlying place-based curricula. In one of the later weeks of the Bread & Building unit, two youth –

a brother and sister duo – wanted to talk about their Jamaican heritage and tried to use Google Earth to show us around the city where their father lived. As Dee and her brother, Don, attempted to explore Port Antonio in Street View, they realized that none of the streets had been imaged. Dee then reasoned that Jamaica must not have highways like the US (which is not true). Dee then pulled up a Google Image search window, and typed in the port town which pulled up many pictures of the most touristy areas. In Figure 14a, I highlight the frames of interest that Dee and her brother used to explore Google Earth including the location of the images from their search result (Figure 14b).

a



b

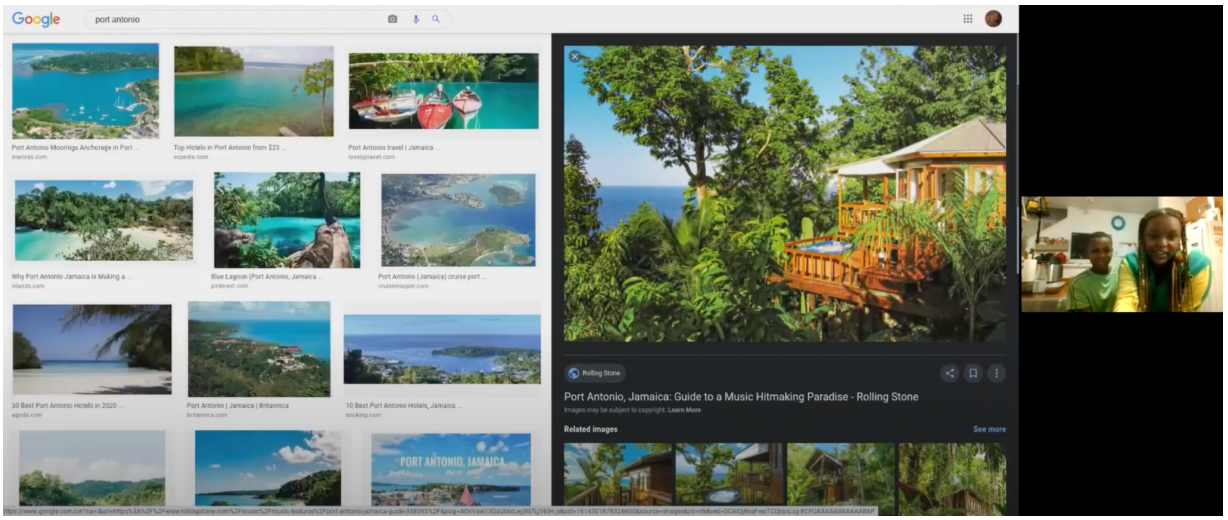


Figure 14. A map of Dee and Don's father's city shown with frames of interest (a) and locations of images from Google Image search (b).

Dee and Don's limited access to visual resources resulted in a truncated, nearly non-existent chronopath of just two frames peppered by disambiguated images that illustrated a very shallow narrative of Jamaica; gaps in Google Earth's modeling resulted in an absence of youth chrono-walks. In comparison to Dee and Don's forced speculation about Jamaica, other youth had memories of their families' homelands to draw upon. For example, during the Somalia session (which I carefully contextualized with curated videos, a cooking lesson and Somali souvenirs), I demonstrated how youth could cull images from Google Earth (which I found none) and so turned to image search which resulted in only images of war. At the end of the demonstration I encouraged the youth to be geographically creative in their storytelling, and sent them into separate breakout rooms with their mentors. One Somali youth, Moh, wrote himself into his story as a terrorist. When prompted why, he began describing a narrative that the mentors repeatedly mentioned to be from the American series "24." Repeatedly he told his mentors that the story was entirely his own. *Why would he write such a thing?* I asked Mohammed, a Somali American staff member. "He hears stuff like this all of the time – that was probably his way of dealing with it." Absent a chronopath to explore, or blue Street View lines to drop into, Moh resorted to the cinematic resources available to him, like

American-produced massively distributed anti-Islamic shows that pervade popular media around the globe (Pless, 2015).

Discussion

In this exploratory conceptual methods paper, I examined how visual renderings of physical places matter for how young people learn about their homes and communities, broadly defined. This exploration precipitated me to document the different ways young people moved (or did not move) through visual renderings, and how different patterns of movement elicited different forms of sense-making. I did this by tracing lines through the digital environments that I could then compare across contexts of Google Earth. In this way, I found that the materiality of Google Earth configurations enabled movement through space and place and by comparing lines of movement, or chronopaths, I was able to see connections to learners' engagement time, place and personal history. I identified three types of chronopaths: chrono-cruising, where youth were embodied in an immersive simulation of Google Earth in VR; chrono-walking, where youth methodically clicked through Street View photospheres to replicate walking down analog places; and chrono-dropping, where youth were observed moving high above the digital earth looking for places to visit. I also compared chronopaths with a lack of chronopaths. These three kinds of paths (and lack of paths) enabled different kinds of temporal engagements. For Jay, chrono-walking more closely resembled a limited analog stroll through his neighborhood. Compared to chrono-cruising, chrono-walking forced Jay to slow down and pay attention to a single moment in time in the present while reflecting upon his experiences of the past. Street View was akin to literally walking down memory lane with his mentor while he attempted to share his day-to-day experiences. Minh's repeated chrono-dropping enabled him to reminisce with his mentor, Em, about his time in Vietnam. Dee could only speculatively imagine what life was like on the ground in Jamaica, and instead relied upon Google Earth which proved problematic for Moh during more creative place-based activities. Moh's experience highlights the importance of visual representation in digital geography, and the underlying harm that dominant cinematic narratives like *24* convey as astutely observed by Edward Said (1994):

> Visual media embody, project, and reinforce these geographic imaginaries, whose task it is to represent the world in order to enable us to navigate and manipulate it, to come to terms with its heterogeneous variety, to live in it effectively (Said, p. 64).

Limited to the cinematic visuals of the dominant media, Moh relied upon cinematic tropes that aligned with dominant Somalian stereotypes or terrorism.

The marginalization of visual resources of lesser-resourced areas in Google Earth contributed to inequalities in youth's place-based learning and identity formation in relation to their families' past homelands. The excitement with which youth chrono-cruised, or "flew" through their digital neighborhood contributed to new possibilities for place engagement and imagination. Jay tried to play at his school yard, and enjoyed comparing the Street View neighborhood to his lived, everyday experiences. Similarly, Minh had many "blue lines" of Street View to explore in Vietnam while searching for the apartment he remembered from his youth. Despite differences in the methods of production of these two encounters (Minh's Street View explorations were produced via local corporations and not through Google), their existence in Google Earth enabled these young learners geographic mobility with which to learn along lines, while the other youth in this study were left to cull from Google image search and their own cinematic memories.

Future Directions and Conclusions

Through ColMap analysis, I was able to deconstruct the digital environment through computer vision methods. ColMap was originally designed to reconstruct analog spaces through video, but by applying the tool to the digital Google Earth environment using video captured through a VR headset, I was able to nearly see through the eyes of the learner in addition to tracking their interactions and speech. ColMap also provided a frame-based method of thinking about learning along lines where lines are produced by the spacing of frames as well as the gaze of the camera. I found a frame-based framework to

be useful for thinking through digital space that learners produce through their cinematic POV. This tool will likely be useful to future interaction studies interested in learning how people learn in immersive virtual spaces where the cinematic qualities of the environment are considered to be an agential factor in learning outcomes.

Overall, the liberation of the first-person POV camera elicited questions about time, place, and history as youth negotiated past, lived encounters of places with simulated and photorealistic *time-images*. Youth's time-confusion (time of day, left-open doors, year, etc.) point to time assumptions that speak to broader concerns of Google Earth's ability to not only exclude, but to also misinform. These underlying power dynamics point to the increased need for postdigital place-based learning methods that encourage critical thinking and discernment.

Future design considerations

Methods like the ones I have explored here speak to the future of learning environments that are increasingly a mixture of analog and digital, or completely digital as demonstrated through Jay's data. Few resources exist for evaluating learning and engagement in completely digital environments or across analog/digital place-based encounters. As these boundaries become more fluid, new methods of research and learning design will be needed. ColMap was useful, but limited as it was originally designed to reconstruct spatial data of the analog world. Ironically, the technology that ColMap employs is the same underlying technology used to render Google Earth's simulated VR environment. It would have been far easier for Google Earth to include methods of evaluating learners' movement through Google Earth VR just as I use Google Desktop pro to evaluate desktop travels. I was fully aware throughout my analysis that if Google Earth rendered the coordinate and trajectory information transparent, and automated path traces, my analytic process would have been far easier. Yet I found that by struggling through the process of creating lines through a series of directional frames, that I began to think about how the digital environment is a moving camera, and its participants its operator.

As geographic imagery is increasingly rendered photorealistic and to-scale through VR or Apple Glasses, these new cinematic geographies become less about information and more about presence and spectacle. Through my data, I tried to show how the visual composition and framing composed by the architects of digital worlds affect movement and temporal engagement. As theorized by Deleuze (1989), the VR camera controls the experience of timing and motion through its alignment of embodied movement with the perception of motion (Bailenson, 2018). Combined with digital geographies, the contextual understanding of visual imagery – of what it represents and where it's derived from – becomes an increasingly important skill of postdigital discernment, thus foregrounding the agency of digital, cinematic geographies as sites of place-based learning. Overall, as people increasingly cross analog and digital boundaries through their place-based engagements, learning along lines will become an even more important unit of analysis to understand *how* and *why* boundaries are crossed and how to design for learning and engagement across them.

Postdigital Conclusions

The corpus of work here represents the accumulation of many years of study and investigation into the reciprocal, ongoing transformation of society through technological advancement and its subsequent impact (or lack of impact) on teaching and learning practices. Through this research, I have focused on developing postdigital methods for the research, design and conceptualization of PBE. I first presented the cartographic continuum as a method of analyzing sociotechnical place configurations across analog/digital boundaries. In the second paper I theorized postdigital design methods that relied upon heterogeneous engagement with place across analog and digital contexts, and in the last paper I conceptualized what learning along *postdigital* lines could look like by tracing lines via screen-recordings of youth exploring Google Earth on the desktop and in VR. Founded upon postdigital theories of learning and engagement, findings from these papers support an agential realist ontology.

Underlying the research questions of this dissertation is a broader question about prevailing theories of mediation. Karen Barad's (2007) theory of agential realism upends traditional conceptions of

mediation that assume that objects are bounded and independent of subjects. But, as Haraway asks in The *Cyborg Manifesto*, "[w]hy should our bodies end at the skin, or include at best other beings encapsulated by skin?" (1985, p.472). Immersed in the digital, I wonder the same about such arbitrary boundaries that form rules around identity and the production of knowledge. Barad (2007) argues that

> Knowledge making is *not* a mediated activity, despite the common refrain to the contrary. Knowing is a direct material engagement, a practice of intra-acting with the world as part of the world in its dynamic material configuring, its ongoing articulation. The entangled practices of knowing and being are material practices (p. 379).

Our "entangled practices" are ontologically produced from epistemological beliefs that determine material boundaries. VR encounters demonstrate how learners are remaking material boundaries of home from the digital. Kay and Zee adopted the material boundaries from Google Earth and reinscribed those boundaries in CoSpaces, thus demonstrating an agential realist place-learning process through an auto-poietic (Luhmann, 1988; Maturana & Varela, 1974) co-constitution of sociomaterial boundaries.

From a pedagogical perspective, new sociotechnical configurations of place call into question the agency of the digital environment itself. Postdigital place-based learning is more than subjects learning about static objects, and more than interactions mediated through digital tools. An agential realist ontology applied to PBE emphasizes that the tools of place are part of place itself. To really learn about place, requires a heterogenous, diffractive approach to PBE where place encounters are compared until similarities among stories establish foundational boundaries and differences are discerned and critically considered as demonstrated through paper two's success with *interpretive distance*, a precursor to historically effected consciousness.

Finally, through lines of learning I demonstrated how *intra-actions* (Barad, 2007)with different sociomaterial configurations of Google Earth produced three types of rhythmic chronopaths. Youth did not move through the static digital or analog environment to produce these paths, rather their movements were co-constituted through intra-actions with the materiality of the digital environment. The material

resources of the digital environment contributed to their placemaking boundaries as much as their lived analog experience. As they intra-acted with the digital neighborhood, they formed boundaries that criss-crossed the analog and digital by exploring chronopaths made possible through the properties of the digital environment. After years of digital PBE investigation and research, I have concluded that environments have far more agency than learners do, which is why heterogeneity – multiplicity – is so foundational to my research philosophy.

Overall, I hope that my research elicits increased consideration by educators, technologists, and policy makers alike to consider the agency of digital environments in learning and becoming. Reframing the analog/digital environment as an agentic and entangled element of learning surfaces underlying environmental and economic inequalities while highlighting individual and collective responsibility and possibilities for collective change. The digital environment is arguably easier to structure and change than the analog; if Google Earth really is akin to Borges' map of empire (1999), perhaps it is time to critically think about who and to what ends the interactive postdigital map should serve.

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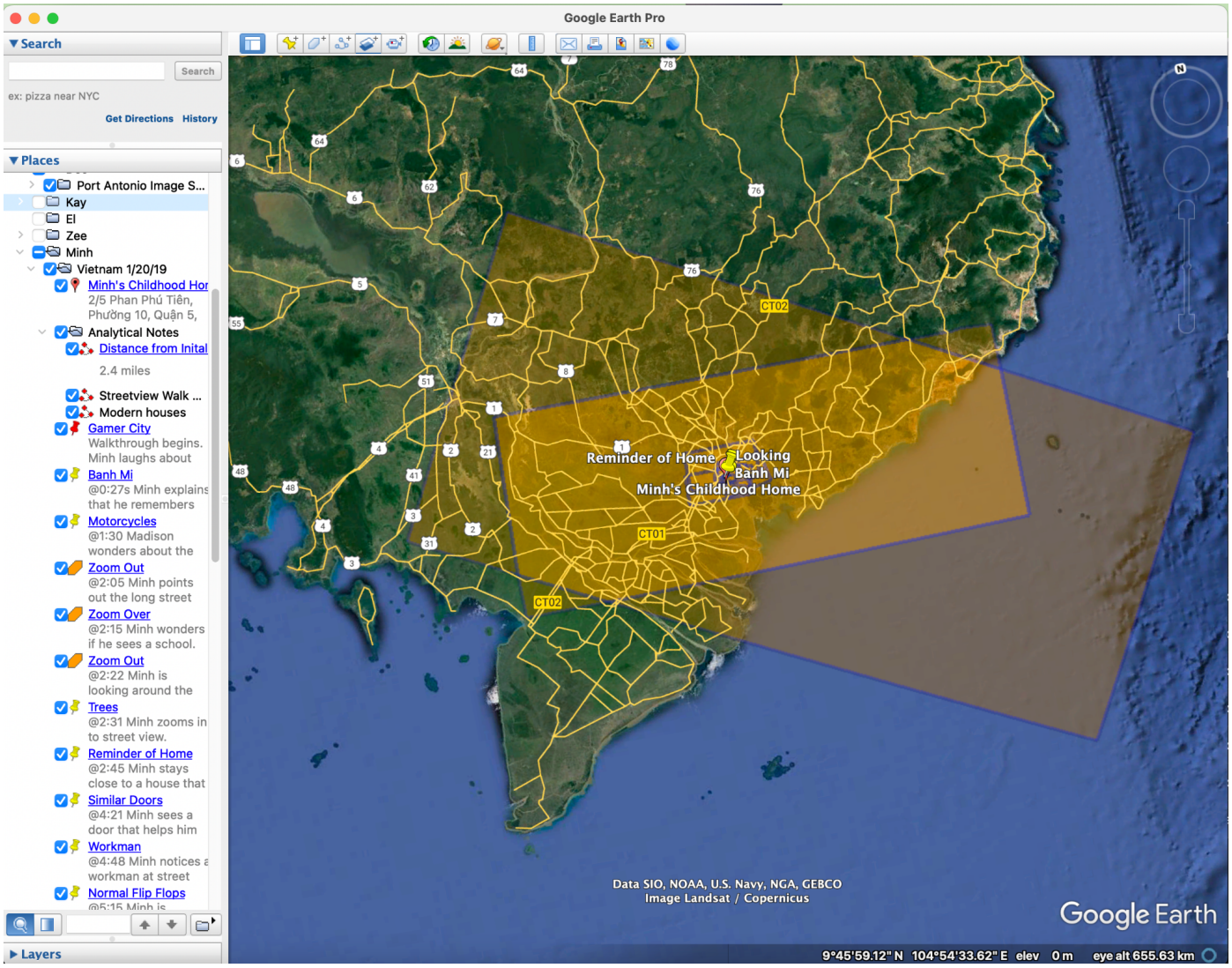
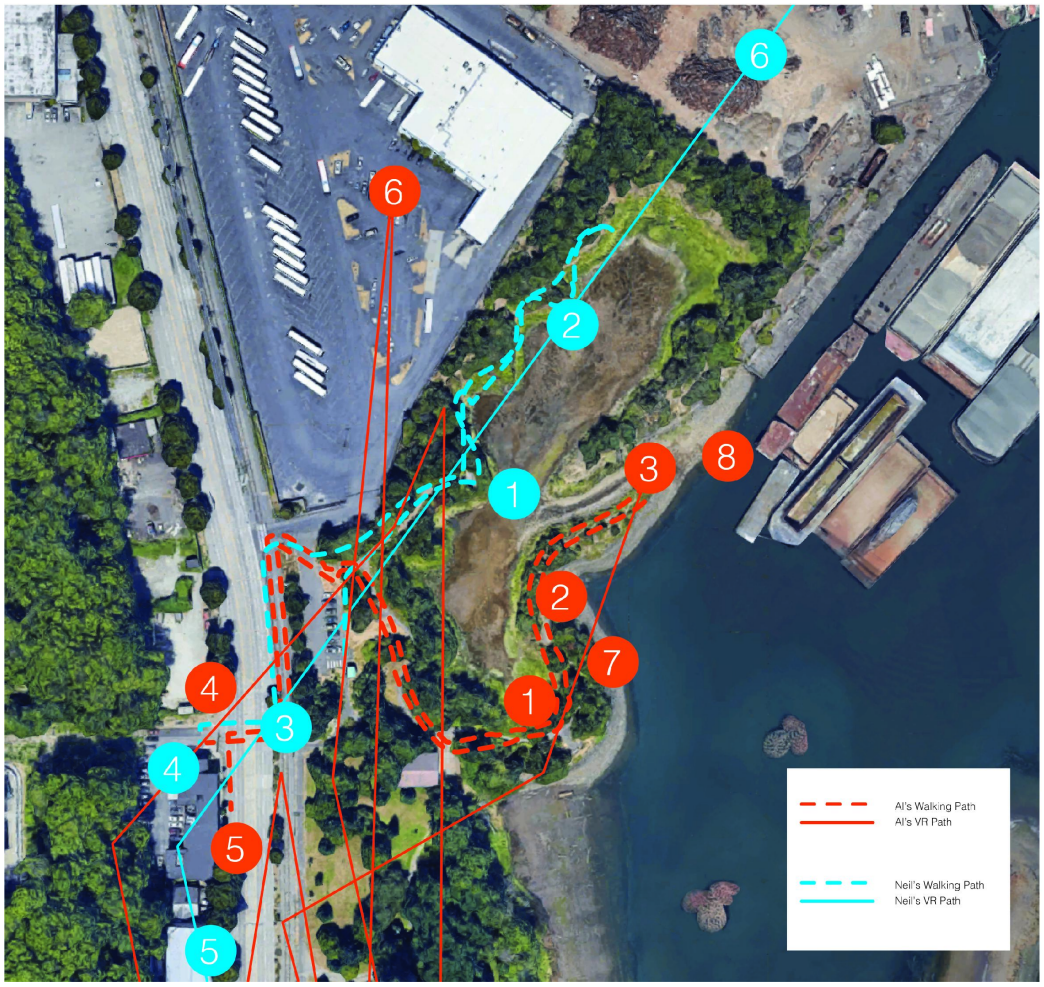
APPENDIX A


Google Earth Pro
Search
ex: pizza near NYC
Get Directions
History
Places
Port Antonio Image S...
Kay
El
Zee
Minh
Vietnam 1/20/19
Minh's Childhood Hor
2/5 Phan Phú Tiên, Phường 10, Quận 5,
Analytical Notes
Distance from Inital
2.4 miles
Streetview Walk ...
Modern houses
Gamer City
Walkthrough begins. Minh laughs about
Banh Mi
@0:27s Minh explains that he remembers
Motorcycles
@1:30 Madison wonders about the
Zoom Out
@2:05 Minh points out the long street
Zoom Over
@2:15 Minh wonders if he sees a school.
Zoom Out
@2:22 Minh is looking around the
Trees
@2:31 Minh zooms in to street view.
Reminder of Home
@2:45 Minh stays close to a house that
Similar Doors
@4:21 Minh sees a door that helps him
Workman
@4:48 Minh notices a workman at street
Normal Flip Flops
Layers
Reminder of Home
Looking
Banh Mi
Minh's Childhood Home
CT01
CT02
CT02
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth
9°45'59.12" N 104°54'33.62" E elev 0 m eye alt 655.63 km

APPENDIX B



Overhead representation of the Duwamish River as represented in Google Earth. Ground paths indicate Group pathways. VR paths represent only Al and Neil's path.

AL'S RIVER PATH Duration: 40 MINS	NEIL'S PATH Duration: 40 MINS
[1] Al stops to take a picture early on in the walk. He takes many pictures – both 2D and 360º panoramas – and includes them in his reflection paper.	[1] Neil stops to take a picture early on in the walk. He notices other students are taking 360º images and quickly downloads the app to join in and try it out.
[2] Al talks about crossing the West Seattle Bridge every day and how didn't know he was	[2] Neil takes a 360º with the group.

going over a river. He takes a 360º image with the group. [3] Al leads the other students to a peninsula. He stands at the very end, and takes a 360º image. His classmates follow his lead and do the same. [4] At the Cultural Center, Al speaks to Blake about Duwamish spiritual practices. In his reflection paper, he relates spirituality to his own, Christianity, and reflects on their similarities, differences, and pathways to knowing the world and self. AL'S VR PATH Duration: 6 Minutes [5] First of the group to use VR, Al starts ~30,000 feet above the virtual city of Seattle and immediately spots the Duwamish. He lowers himself quickly to 100 feet above the ground and passes back and forth repeatedly as he orients himself. [6] Recognizing more of the River, Al lowers himself to roughly ground level and "re-walks" the banks. He first notices there's no trash. [7] In VR, Al can control the sun to see stars over the city. His classmates gasp at the stars, ad Al exclaims "Stars! You don't see those in Seattle!" He "raises" the sun and sees the exact point he was standing at the week before, taking 360º image with his camera. [8] Al navigates to the same spot and remembers what he saw: "Woah, there's the boat, and that weird thing over there!" Al gestures with the controller. Classmates watch and nod in agreement, having shared in both the real and virtual experience	[3] A busy highway, no crosswalk, and a lack of public transport make for a stressful trip to the Duwamish Longhouse. [4] At the Cultural Center, Nick hears Cecile speak to the group. Her appearance was unexpected, but her impassioned plea for Federal recognition for the Duwamish Tribe was mentioned by Neil in his reflection paper. Neil's VR PATH Duration: 4 Minutes [5] In Google Earth VR, Neil starts ~30,000 feet above the virtual city of Seattle. He lowers himself to the city center while facing North, and follows the River backwards through the Port until he reaches the Longhouse. [6] Once he receives affirmation from his classmates that he had arrived at the correct spot, he immediately ascends and returns to Seattle. "Anyone like football?" he asks upon reaching Century Field and peering down into the stands ~10,000 feet above the city.