Paths Toward Hybridity between Equity and Field-Based Environmental Education for Novice Science Teachers

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It has become increasingly critical that we no longer consider environmental and social justice issues separately. Well-researched examples of real-world paths toward hybridizing equity and field-based teaching in science education are rare, yet are especially important now, not only as we move towards anti-racist pedagogy, but also in response to the global pandemic and climate change. Cultural-Historical Activity Theory (CHAT) drives our analysis, with Structural Agency Dialectic (SAD) and Critical Theory (CT) providing additional lenses/foci to guide our data collection data and analysis. To add to research on equitable field-based environmental education and to theorize it in newer ways, we trace the thematic markers as well as discursive traces that characterized the process of hybridizing in this research intervention. We focus on structural and agentic themes that advance or constrain movement towards hybridizing in an equitable field-based environmental education (FBEE) year-long, secondary science preservice science teacher (PST) professional development program. Data analysis focused on interviews, reflective journal and field notes, so as to capture emerging tensions directly through the PSTs' experiences, rather than program analysis. Three emergent contradictions emerged: (1) Negotiating the meaning of the term equity in theory and practice; (2) Unpacking the meaning of grit as a tool for individualism, and (3) Negotiating the meaning of resources as mediational means. This research adds to a larger movement towards fostering

equitable, accessible and anti-racist field-based environmental education.

Keywords: pre-service teacher professional development; field-based education; cultural historical activity theory; critical theory; equity

Introduction

Field-based teaching is an important pedagogical tool in environmental education. However, as the field remains a space of historic whiteness and exclusion (O'Brien et al., 2020; Morales et al., 2020; Finney, 2014), it is increasingly important to critically reflect on and conduct targeted research to expand field-based environmental education (FBEE) into a more equitable and inclusive space. Recognizing that FBEE and equity have arisen from different theoretical and epistemological foundations, our research centers on attempts to reconcile them to and locate potential overlap or 'hybrid' zones that allow both fields to be honored. Following Bhabha (1994), we define hybridity as "a metaphor for the space in which cultures meet...the possibility for creative forms ...produced on the boundaries of in-between forms of difference, in the intersections and overlaps..." (p. 1). We situate hybridity in the intersections and overlap between FBEE and equity, keeping in the forefront social, cultural and historical differences in origins, as potential areas of overlap.

More generally, we note that while there is much research exploring environmental/sustainable education professional development both in the U.S. and internationally (de Haan, 2006; Murphy et al. 2020; McDonald & Dominguez, 2010), examples of hybridizing equity and FBEE in pre-service professional development in science education are rare (Chinn, 2012; Monhardt & Orris, 2007), and the research that does exist is too often strategy rather than theory based (Carabajal, Marshall, & Atchison, 2017; Barrable & Larkin, 2020). In order to capture movement toward hybridity, we focus on structural and agentic thematic markers that appear to advance or constrain hybridity. This research is important as it begins to re-imagine FBEE, to extend its boundaries, challenge some beliefs and reposition FBEE within a more syncretic theoretical framework of equitable theory and practice.

We define field-based environmental education most simply as extending teaching outside the classroom into real-world settings, yet it is more than that (Lonergan & Andersen, 1988). We draw from Cole (2007), using an 'expansive view' of the environment/field, in which it becomes a place "rich with dynamic cultural, social, economic, political, historical contexts and perspectives that frame and construct the ecological processes within them" (p. 39). We define equity most simply as providing resources in proportion to need (redistributive) (Dawson, 2014), as opposed to seeking only equality, that is proving equal portions to all. Using this framework, we position "the use of multiple, diverse, and even conflicting mediational tools as promot(ing) the emergence…[of] expansive zones of development" (Gutierrez et al, 1999, pg. 286).

Moje et al. (2004), suggest that such expansive or hybrid zones can "serve as a navigational tool to help them [students and teachers, community members,

administrators, and so on] to understand conventions and practices of a new discourse community" (p.53) To do this, we follow discursive traces of emergent hybridity as PSTs attempt to negotiate common meaning as two very different disciplines overlap (Engeström, 1987; Sannino, & Sutter, 2011). To do this we must understand more clearly where equity and environmental theory and practice arise, that is, their philosophy, mediational means and expected outcomes.

In terms of equity, we note that within the US, for example, it has been strongly suggested that FBEE has been created by and offered to mostly middle-class, western European-Americans (Newsome, 2020; Taylor, 2019; Toomey, 2018), but also that those most affected by environmental /climate change (Taylor, 2019) will be those minoritized (Tolbert, 2015) and typically less economically secure populations (Mendelsohn et al., 2006). Critical theory (CT) provides us a lens for studying how to more broadly situate inequities at the intersection of race, gender and culture. Because it is easy to fall into the ritual of white (often male) middle class field/environmental education as the norm (B. Moore, 2013), we position this research intervention first, as equity work, and second, as environmental work, understanding that these two should be conjoined, but are not. We note that people of color are often subject to practices in FBEE that leads to othering and exclusion (Toomey, 2018). powell & Menendian (2017) define othering as, "as a set of dynamics, processes, and structures that engender marginality and persistent inequality across any of the full range of human differences based on group identities." (pg.15). Unfortunately, such othering practices are often accepted as normative behavior.

Such othering fits well with how scholars have positioned FBEE increasingly within a neoliberal philosophy of consumerism, competition and individualism (Apple, 2017; Fletcher, 2016). As Carlone et al. (2016) argued we must "move beyond the neoliberal grip on knowledge production in field ecology, contesting prototypical scientific epistemologies that are reductionist, techno-rational, and perpetuate subject/object dualisms." (p. 209). Neoliberalism also helps us to understand the roots of the individualism vs. collectivism divide as it has steadily pushed the education systems towards a market economy based in part on individual rights, commodification and consumerism. Thus, individualism is a hallmark of neoliberalism and is an important discursive marker in teacher professional development as teacher collective power is deliberately diminished, students are increasingly tested, and schools become businesses. (Tolbert, Spurgin & Ash, 2021).

Noting these and related tensions and wanting to move toward equitable FBEE, the research intervention project we describe here challenges such dominant and normed discourses by working with young socially conscious teachers in training at a progressive university system, and an emergent community of scholars whose stated goals include social justice. To contribute to this body of research, to theorize in new ways, and, perhaps, to shift the focus of future research, we trace the most salient discursive aspects, noting how structures enhance and/or constrain success (as measured by past and present practices, discursive and written products reflective of success or conflict) in year-long secondary science preservice teacher (PST) professional development program focused on equitable FBEE. Theoretically we rely on Cultural Historical Activity Theory (CHAT), the Structural Agency Dialectic (SAD), and Critical Theory (CT) to potentiate

the complex analysis required for discursively tracing contradictions embedded in the proposed hybridizing process. Following CHAT principles, we seek out contradictions as they emerge (Foot, 2014), exploring both individual and collective emergent themes. Taken together these three frameworks allow for a more nuanced and comprehensive analysis than either one could do on its own.

Theoretical Framework

Cultural historical activity theory (CHAT) is our overarching framework within which we situate the structure agency dialectic (SAD) and critical theory (CT). CHAT, both systemic and flexible, is a framework nuanced enough to capture multiple levels of activity, people, mediational means, rules, hierarchy, and community. CHAT is object oriented, invites contradictions, is historically based, dialectical and expansive. Structure and agency exist in a dialectical relationship as does all of CHAT. Structure and agency enhance and constrain each other, and are mutually constituted. We argue that SAD can help provide a more fine-grained analysis of PST agency or lack of it within the activity framework. CT provides a much-needed intersectional lens, drawing attention to the role power, race, identity, and gender have played in systems of education. As a combined conceptual frame, the tri-part frame supports research that is equity driven, destabilizes neoliberalism and dominant ideologies, engages in multi-sited analysis and uses an intersectional lens. We acknowledge the overlapping influences of power, identity, in order to dialectically explore how environmental education can be re-positioned for expansive, equitable community-focused teaching and learning.

Because CHAT is designed to embrace dialectical relationships, it welcomes and seeks out contradictions (e.g., for whom and by whom is FBEE designed; individualism vs. collectivism), presuming that contradictions actually drive and transform activity systems (Engeström, 1998; Foot, 2014) encouraging expansion toward aspects we may not have known before. This generative stance allows us to expect and thus make space for unanticipated outcomes. Thus, CHAT, having already used to analyze classrooms, companies and hospitals, functions as all-purpose systemic tool that accommodates interdisciplinarity works well with specific constructs such as the structure agency dialectic (SAD) and a variety of mediational means (for example, language, discourse, books, computers, open space, land, etc.) (Engeström, 1987; Langemeyer & Nissen, 2005). CHAT takes into account the varying components/nodes of an activity system, including the individual (subject- i.e., Pre-service Teachers), mediational means (tools- i.e., Resources of all kinds), object (motivation, outcome- i.e., Equitable FBEE), community (biology dept. county, education dept), rules (e.g. state mandates for credentialing) and division of labor (academic hierarchy, local school norms). We observed interacting systems, including a department of biology at a university, preservice science teachers in a teacher education program, the county office of education and/or the natural resource management team.

Here we focus primarily on mediational means naturally moving across such multiple systems, including money, expertise, tools such as hygrometers, land, cultural background, curriculum goals, lesson plans or experts. Gutierrez et al. (2009), argue that such mediational means or tools are both essential and changing parts of any activity. CHAT also provides a framework within which to study the

details of the structure agency dialectical (SAD) tension between individual PSTs and potential enhancing and/or constraining collective, structural forces (Buxton et al., 2015; Cole & Engeström, 1993; Varelas et al., 2015). SAD (Sewell, 1992) then, allows us to frame our thinking in terms of specific factors that both advance and constrain PSTs' direct experience of agency, but also whether and how they might position themselves as individual agents or part of a larger collective. Specifically speaking of agency, Sewell (1992) suggested it, "is the actor's capacity to reinterpret and mobilize an array of resources in terms of cultural schemas other than those that initially constituted the array" (p.17). By actor/subject, here we refer to the PSTs, but also note the surrounding community of mentors, researchers and university and county resources. Sewell (1992) further suggests evidence of agency, sometimes described as transformative agency when situated within CHAT, when people use tools in novel ways, or in places where they "don't belong." For all these reasons, mediational means then, are a central part of our work, relying on both typical and creative usage, which we can only recognize, if we are open to unknown outcomes (Engestrom, 1987). This bodes well for activity, interactions and mediational means seemingly outside of the 'norm' or 'settled expectations' (Bang et al, 2012; Bang et al., 2015; Moore, 2013), especially known when they work to transform previously 'known' situations or systems.

Gutierrez and Barton (2015) suggest that, "the structure–agency dialectic provides conceptual and analytic tools for re-reading and re-naming some of the enduring equity dilemmas faced in science teaching and learning, offering inroads to seemingly intractable problems" (p. 575). As we shall come to see, both agency and structure (and the inventive use of mediational means) are multi-layered, as are their interactions (Buxton et al., 2015; Varelas et al., 2015). Using SAD we recognize that PSTs can and do have and do gain agency (as well as identities as soon-to-be teachers) in the PST programs, yet, the possibilities are not unbounded. One such intractable problem may be how to hybridize equity issues with environmental concerns without losing nuance or depth of either discipline.

Critical Theory (CT) reaffirms our commitment to social justice, nondominant science ideologies, and praxis. As Mensah & Jackson (2018) highlight, in CT:

> race matters, history matters, voice matters, interpretation matters, praxis matters ...because "it is not enough to simply produce knowledge, but to dedicate this work to the struggle for social justice" (Zamudio et al., 2010, p. 6). (pg. 7)

We keep these tenets central to intersectionally examine the role, power, race, and/or gender may have within the field-based emergent teachers activity system. This stance allows us not to be only critical of the system, but our own analysis. In FBEE, specifically, we aim to move the more common approach of socially critical theory (Walker, 1997) to a place of praxis and expansion, using CT address not just environmental justice but social and racial justice.

Methods

Context

The data from this research draws from the pilot year of a professional development program at a large west coast university, co-sponsored by the Education Department (the Master of Arts/Credential (MA/C) Program), the Biology Department, the Natural Reserve System of the University system, and the local County Office of Education (COE). This local consortium emerged due to a shared commitment to advancing diversity and equity in environmental education through field-based pedagogy, evidenced by the following descriptions: (1) The MA/C program is an intense one-year program with a focus on social justice and educational equity; (2) The Biology Department offers the most field courses in the university system, and: (3) The local COE has one of the few environmental literacy coordinators in the state. This unique partnership was rather novel, its pilot years meant to create a model for a potential university system wide professional development program for teacher education.

The FBEE program focused on the efficacy of a new field-based environmental pedagogy intervention designed to address the dearth of diversity of backgrounds and perspectives in the environmental science sector, advancing a specific and targeted equity approach. Collective activity included the integration of FBEE content into two of the science student teachers' courses, quarterly Saturday workshops, and implementation of program strategies in participating in PST/CT classrooms through the development of lesson plans. The pilot year of this emerging collaboration faced challenges as it progressed as the partners were new to each other, the program was situated across multiple schools and districts operating under state credentialing guidelines, and the budget for the program was limited and temporary.

Participants

All secondary science MA/C students were invited to participate in the 2018-19 academic year. Applicants were asked to reflect on the program goals, as well as their ability to commit to the time required to participate. From a cohort of fourteen mixed science (chemistry, physics, biology, etc.) credentials, five participants applied and were selected, largely those credentialing in biology. There were three male, Sandy, Skip and Hilago, and two female participants, Cheyanne and Maggie (see Table 1). All PSTs but one (Skip) were paired with cooperating teachers (CTs) with varying experience with field-based/environmental pedagogy. Students in the MA/C program are assigned two placements, one at the middle school level and another at the high school level, the second one longer than the other. These pairings came with the second placement CTs. Participating CTs and PSTs were each paid a stipend for their participation.

Data Collection and Analysis

Data collected from the participating PSTs included pre/post interviews, quarterly

reflective journals, ethnographic field notes of workshops, associated MA/C student coursework (including research papers and lesson plans), surveys, and reflective presentations on their program experience. Data was collected by Race, as Ash was an instructor in the program and could not ethically view the data until the participants had completed their course with her. Interviews were audio-recorded and transcribed through a web-based service (temi.com). The data analysis focused primarily on interviews, supplemented with the reflective journals and written course work. Iterative rounds of coding initially identified larger tensions/ themes, which were then refined into specific codes at three levels of analysis: the professional development program, the PST placement contexts, and individual PSTs. Data was critically reviewed and re-reviewed by the authors together and separately. We utilize discourse tracing, as described by LeGreco & Tracy (2009):

> Discourse tracing provides new methodological resources for gathering and analyzing data associated with case studies, especially those focused on issues of change...it builds from a critical and poststructural epistemology that celebrates the importance of power, multiple levels of discourse, practice, and participant voice…Moreover, this approach can result in rigorous naturalistic generalization (Stake & Trumbull, 1982)…

We traced the contradictions/tensions we noted during PST 'work' within the newly expanding space as discursive markers/traces, using these to identify the emerging hybrid themes. These traces allowed us to glimpse change in views over time, especially in terms of criticality and inconsistencies. Hybrid then was represented by the disparate and unifying discursive traces signaling overlap or merging of pre-existing differences in practice or worldview. By comparison, we could also note where and for whom this did not occur.

For example, for the PSTs, discursive traces uncovered previously less-understood inconsistencies/contradictions, such as differing views of PST and student access and key mediational means/ program resources that might scaffold success. The data presented here is drawn from all participants, but focuses on two PSTs, self-represented as a queer Latino male, Sandy, and a Caucasian cis-woman, Cheyanne (see Table 1). Although all five in the research cohort represented the process of hybridization to varying degrees and in quite different ways, we selected these two because of their degree of engagement with the program and the criticality they brought to their reflections of the program.

Findings

The goal of the intervention was: 1. locating thematic markers, 2. following discursive traces during negotiation of themes, 3. noting how these constrain movement towards hybridizing equity and FBEE. Overall, we took into account three-levels of analysis; the overall program, the CT/PST dyad pairings, and individual PSTs. We concentrated on specific areas requiring significant negotiation both in oral, written, real-time and overtime form: (1) Negotiating the meaning of equity; (2) Identifying discursive traces of appropriating a grit/individualistic stance and (3) Situating and negotiating resources, which we have positioned as mediational means.

Negotiating a Joint Meaning of Equity

We immediately noticed a disjuncture concerning the actual meanings of the word equity (often seen as equal, diversity, inclusion, social justice, etc.) at both individual and collective levels across all partners. Different versions of the meaning of equity appeared early and quietly but persisted throughout the first year. The meanings and the differences between some of the most commonly used terms (equity, equality, diversity, etc.) were not made explicit at first, partially because this was not originally seen as an area needing elaborate negotiation. People spoke in generalities, until it became clearer that participants did not mean the same thing. As participants' ideas changed it was not surprising that the meaning of the program itself (based on equitable FBEE) needed re-negotiation. As with past environmental alliances, some meanings and beliefs had to be established within the actual work or practice of the community (Kempton & Holland, 2003) in both the field and classroom.

The mismatch of meanings emerged most clearly in the quarterly workshops, when all the partner communities met. The natural science faculty's (who offered the first workshops) interpretation of diversity or equality centered on offering the same kinds of activities they had used with university students, to the PSTs, who were then expected to use them with their minoritized middle and high school students. This equal/same lesson for all approach is a classic view of equality; everyone gets the same. PSTs, on the other hand, having been imbued with a social justice and equity stance in their MA/C program immediately recognized the conflict between the 'same lesson approach' and their current understanding of equity. Cheyanne said:

> A lot of the kids that they're (university science professors) working with, it's not equitable…Let's talk about K-12 when we're working with kids of all levels, all backgrounds. That's where the conversation on equity needs to be happening.

Maggie said something similar, "It (workshop) didn't address the idea of equity and bringing students who wouldn't already have that experience into it (the field)." Cheyanne and Maggie recognized that using the same pedagogical approach for college students with K-12 students doesn't take into account the additional and sometimes unknown challenges equitable FBEE engenders. In short, it is not equitable according to their definition. But it did conform to other professionals' views of equality.

Sandy also commented on the mismatch between the workshop presentations and the program goals of equitable FBEE. Reflecting on the program, he said:

> No. I think that [equity] is what the cooperating teachers (CTs) and the student teachers (PSTs) wanted. I think everyone associated with the master's program, that's what they wanted. But the people that we brought in weren't addressing those issues. And I think just re-aligning what the overarching goal is for everyone, including participants [and] guest speakers about why we are speaking at this specific workshop would be better and put everyone on the same page.

Sandy stated the contradiction quick clearly. By this we mean the power inequalities of student and program designers set up an inequitable situation for them and by proxy their future students. Using SAD, we can argue both Cheyanne's, Maggie's and Sandy's recognition of a mismatch or in CHAT terms a contradiction in collective meanings of the term equity appeared to have motivated increased agency on their part in the face of structural programmatic constraints. Within CHAT such contradictions are valued and are said to drive systems to expand and transform, so that the final product cannot be entirely predicted in advance. This particular contradiction motivated them to advocate for change, which eventuated in a new format the next year, especially in terms of negotiating the meaning of the term equity early and often.

In a separate academic program component, Sandy wrote a research paper titled "Accessibility for Marginalized Folx in Outdoor Education." He specifically addressed the lack of accessibility for people like him,

> ...it kind of fueled my frustrations with [the program], kind of made me realize that I can't be this passive person in a community that needs active voices.

Sandy wanted equitable approaches to FBEE programs for marginalized folx like him, and personally motivated to change the program. When the FBEE program did not provide that, he announced in this research paper that he planned to be more agentic. One product of his increasing agency was an emerging hybrid stance which, among other actions, rejected the common diversity language of 'equal for all'. Instead, his new posture announced an expansive view of what heretofore has passed for normal in his own training, as an undergrad in this same university with some of these same professors. The hybridity in this case resides in the fact that he was pushing beyond the boundaries of so-called 'normal' EE in that university.

Sandy and Hilago both recognized the tension between diversity and representation both within and outside their MA/C program. Sandy noted the lack of diversity in program leadership, "There isn't any people of color (POC) representation other than one Education Faculty." Hilago noticed that the lack of people of color as guests in the workshops, "...just having different people of color come in as well. I felt like it would've been helpful." While not surprising, given the historic whiteness of teaching and FBEE, CT reminds us that critical voice is essential for change to happen, especially if that voice comes from a less powerful position. Both students were POC themselves and proactive in different ways. In an 'end of the program' debrief, all PSTs commented on the lack of explicit/concrete focus on an equity aspect of field-based learning, asking, for example, "Who are we serving?" and "How do you do field-based learning with students/schools who lack the resources to go beyond the school grounds?" Thus, despite the sentiments coming from many PSTs as we saw , the larger burden of critiquing inequities in practice and diversity fell on the POCs in the group.

Unpacking the Meaning of Grit as a Tool for Individualism

Grit, a term popularized by TED talks and books (Ducksworth, 2016), has roots in the American "pull yourself up by the bootstraps," strongly individualistic norms emphasized since the 1960's by neoliberalism proponents that emphasize globalization, competition, consumerism and of course, individualism (Apple,

2017; Tan & Barton, 2008). While the concept of grit itself is not problematic, those who use it place the emphasis on individual agency, failing to recognize larger systemic barriers and challenges teachers and their students face. As one conservationist suggested:

> Many folks in the conservation / ecology circles I move in will refer to getting reluctant students into the field as a "forced march". I've said it myself many times without thinking much about where that phrase comes from or how it might be received. Lots to unpack and retire in that language.

The language of grit and unlimited agency has become so normalized that teachers, scientists and environmentalists use it without reflection on alternative meanings. For example, language like "forced march" can be extremely damaging for Indigenous or Black students, whose ancestors were forced to march to reservations or on chain gangs, often to their deaths.

Gutierrez et al. (2009) argued that literacy must be remediated; we suggest FBEE requires similar linguistic remediation. Take this comment by Sandy, who focused determinedly on equity and social justice in his approach to FBEE:

> I asked, what if the kid doesn't want to do this? And then the instructor said ...well, you just gotta make them do it…And that really put me off because that was really big, pull yourself up by the bootstraps kind of thing. Force kids into doing something until they like it or until they're successful. And I'm like, no.

Scribner & Cole (1973) said, "searching for specific 'incapacities' and 'deficiencies' are socially mischievous detours" (pg. 558). By this we mean looking for deficits and providing assumed corrective methods, as noted above, 'make them do it' is not consistent within equitable social, field-based practices.

Situating Resources as Negotiated Mediational Means

The contradictory translations and meanings of the term resources was not obvious at the beginning of the FBEE program, as meaning was undifferentiated in important ways. Again, discursive traces led us to this theme. We have situated resources (within a CHAT framework) as mediational means or tools for achieving desired objects (outcomes). In the case of FBEE work, any perceived mediational means (and there was a wide range) can take multiple forms, as can the perceived motivation for any particular outcome (help society, save money, etc.). An equitable stance concerns distributing resources according to need and not necessarily in equal measure. It appears that PST participants and leaders interpreted 'resource' through two lenses, (1) similar to equity, we trace the interpretations of what the word resources actually meant; and (2) implementation in practice, that is, how resources were identified, distributed, and used. The meaning of both these categories shifted over time, and meanings of resources varied at the different levels of analysis.

Not surprisingly, PSTs interpreted resources as the things they need to make FBEE teaching practice work. Some leaders viewed them as land, money, and lessons, others as an equitable stance and desire for social justice. This contradiction was revealed over time. From a programmatic perspective resources included tangible items, such as transportation to sites away from school, and the

less tangible as well, such as degrees of mentoring by CTs. As seen in the two concept maps, representing PSTs past experience with FBEE (Figure 1), Cheyanne and Sandy entered the program with differing expertise and views of resources. The primary difference, beyond specific contexts for work, was Sandy's strong reference to structural constraints for equity, including lack of resources.

Cheyanne located her goals on one side and experience on the other (Figure 1.A), explaining the positions and providing strong evidence of experiences and subsequent questions. She synthesized her past experience but also what she wanted in the future. Cheyanne was placed in her student teaching in a 6th grade middle school science classroom; unlike other PSTS, she was paired with the same CT the entire year. Her mentor/CT was a veteran teacher with many years of experience incorporating FBEE teaching into the classroom. Cheyanne recognized the impact of this:

> My CT is a big part of my "Goals of …" side of my concept map because she consistently brings the field into her classroom. I think this is a very sustainable approach to FBEE learning. ... all classrooms have the ability to make their classroom a field, where students can operate as field scientists.

The scaffolding from her CT significantly broadened her understanding of FBEE. The combination of past experiences and the current scaffolding from her CT helped to shape her understanding of resources, especially in regard to equity when students cannot go on actual field trips due to a variety of reasons (access, money, pandemics). Such an expansion of perceived and real resources (i.e., her CT) marked Cheyanne's ability to move towards equitable FBEE in her current and future work. We see this later in her job selection, as she states in an interview discussing why she chose a job in an urban area instead of a nature-rich one,

> ... it just kind of smacked me between the eyes. thinking of all of these ideas of how to do (FBEE) in urban areas, that I want to take the skills that I have of creating lessons and curriculum and take them to a place where it needs it the most.

Sandy positioned his concept map around his role as an educator doing FBEE. Focusing less on past experiences, he emphasized emerging tensions novice educators, such as himself, must navigate. These included systemic barriers and the role of social justice. His question, "How do I do all of this at the same time?" reflects both conflict and desire to do things differently (Figure 1.B). Unlike Cheyanne, who completed her concept map near the start of the program, Sandy created his concept map about two months later:

> I feel as though [program] has these ideas of helping a certain audience of students. Students who come from impoverished and underfunded schools and communities, especially students in grades 6-12. However, most of the resources and tools that we have been working on are not necessarily helpful to the goals made for this program.

This stated tension between program goals and possible success of implementation forced us to step back and systemically analyze the inequity in the essential resources provided to the PSTs. For many program leaders, despite best intentions for equity, resources were often seen as generic field-based pedagogical tools, with little thought given to the specific level of instruction. Frankly, our view of what resources could be expanded a good deal during this study. Sandy,

Cheyanne's and the other PSTs critical reflection revealed a programatic lack of differentiation in negotiating and managing teacher resources for working with POC in EE.

Similarly, regarding placement-level resources, unlike Cheyanne, Sandy was placed with a CT with less FBEE experience, in a high school ninth grade science classroom with significant departmental and structural constraints, including unit timing, curricular alignment and hesitation from other teachers to alter the curriculum. These constraints limited his agency, as he notes, "The program hates when I say this but I'm just a student teacher and I'm also like, don't say too much or else you lose out on a job opportunity." This reflects the limited agency that PSTs often have in their classroom placements (Tolbert, Spurgin & Ash, 2021). Limited agency and lack of equitable FBEE and CT resources hindered Sandy's ability to create and implement fully equitable field-based lessons in his placement.

Discussion

Using CHAT, SAD and CT, we analyzed the incipient contradictions, challenges, affordances, as well as some outcomes, as PSTs moved toward hybridity in a historically white exclusionary field. One goal of creating equitable FBEE was understanding how teachers can understand equitable field-based pedagogy using a rich set of mediational means. We noticed movement toward hybridity or, as we suggest 'expansive zones of development', in different overt forms, yet still grounded in theory, using similar (and different) mediational means. We see that subjects/PSTs used mediational means towards achieving objects (outcomes). The subjects Sandy and Cheyanne had similar (workshops, classes, cohort) and sometimes dissimilar (CT, lesson plans) mediational means. Their community of practice largely overlapped except for the classroom experiences with students and CTs. While each had located an expansive zone within which to work toward equitable FBEE, in actual practice, because of structural constraints, their goals were not realized equally. Cheyanne experienced more degrees of freedom than Sandy, while Sandy advocated for a good deal more agency within the program.

Both left the program and took new jobs in challenging urban environments focused on equity concerns. For Cheyanne, the program provided rich resources and mentorship that impacted her confidence and appropriation of program goals, impacting her agency. She was confident of her ability to implement field-based teaching in her future urban placement.in the face on significant structural constraints. Sandy recognized the systemic inequity that persisted even in a program focused on equitable approaches, as he shifted to critical advocate. He viewed the program with a critical stance, recognizing the persistence of whiteness, inequitable resources, and problematic ideologies that exist overall in FBEE. His new job placed him on the frontlines of such work. This critical lens worked toward pushing program organizers to recognize their own role in perpetuating whiteness in the field. The subsequent year of the program incorporated his and Cheyanne's, and other PST's suggestions.

Just as CHAT welcomes contradictions, SAD is centered on one, and in this case, the dynamic dialectic between teachers' individual agency and institutional/structural constraints. We recognize teachers can and do express agency as they can, also noting the forces working against them on a local and global scale,

especially the overemphasis on individualism that neoliberalism promotes (Apple, 2017). With this mindset, the blame for failure as well as the reward for success can be artificially located in the individual, rather than in the structures that position, enable, and/or constrain the individual (Gorski, 2009; Valencia, 1997). As the research in this intervention is aimed at re-mediating the collective understanding of equitable FBEE, it is expected that many more hybrid or expansive spaces would emerge to challenge dominant individualistic narratives. For example, this process of hybridity created a space for our PSTs to push against the individualistic grit, "make them do it" narrative that has existed in FBEE.

At the program level, the FBEE program aimed to provide collective and equitable resources, both intellectual constructs and the material 'stuff' of teacher's work. Within the larger systems of activity of this research intervention (county, university, classroom, field), there were attempts to provide and connect resources beyond the individual teachers and classroom level. This proved to be challenging. The hybrid, expansive spaces created by the PSTs showcased how some mediational means moved the system towards more equitable FBEE. This negotiation provided valuable insight into how to improve future iterations of the system, but also the fault lines we noted. For example, Sandy's critical stance and Hilago's comments nudged the leadership to include more voices and perspectives of people of color in the next year of programming.

Limitations

We recognize this study is a U.S. specific example. However, there are numerous CHAT- based teacher professional development research studies, especially in Europe (Ellis et al., 2010). We hope the theoretical grounding and conceptual framework will provide a useful lens across all environmental education spaces, especially for those seeking to critically examine their practices. We also know this is a limited data set from only one year of a pre-service teacher professional development program. While we took measures to triangulate our data, we recognize our findings may not be generalizable and may be subject to researcher bias. We also note our roles in the program as a potential source of bias, Ash as a lead founder of the program, and Race is a graduate student researcher with a background in field ecology.

Conclusion

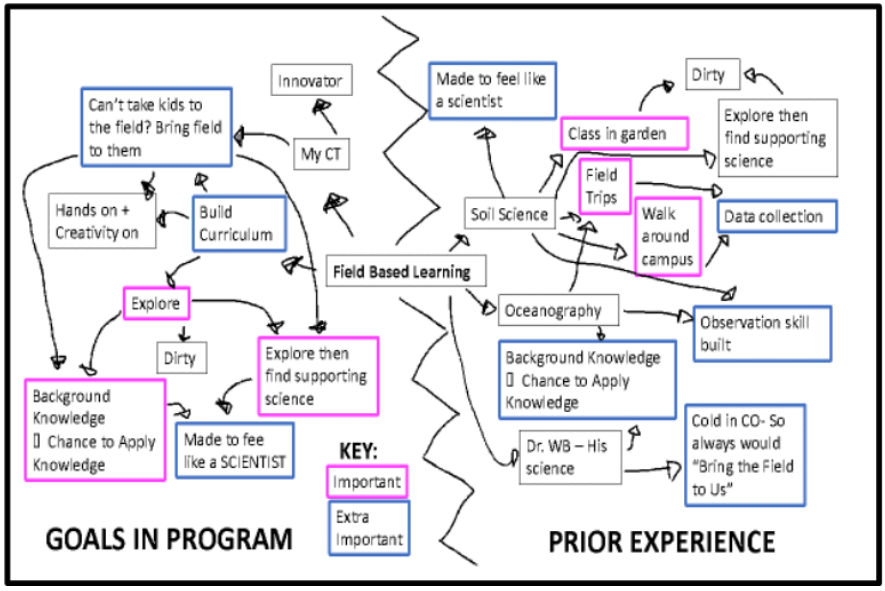
The field of environmental education (EE) is rife with contradictions, structural constraints, emerging consumerism and sometimes unbridled individualism (Fletcher, 2016). EE, in fact, appears to be a perfect area of study for the type of analysis we have suggested. We have argued that cultural-historical activity theory (Engeström, 1987; Engström & Sannino, 2011) with attention to the structure agency dialectic and centered through a critical theory lens, provides the tools for uncovering and fully examining systemic analysis of contradictory relationships. We have offered three dialectical areas, views of equity vs. equality; deficit (grit) vs. resource views; and conflicting meaning of resources, which we positioned as mediational means, and as the levers for transformation (Foot, 2009).

In the age of COVID-19, it has become increasingly evident that we can no longer consider environmental and social justice issues separately. The data presented here highlights tensions that emerge when attempting to incorporate equity-based pedagogy in science teacher preparation. Equity is achieved through providing resources according to need rather than equally. As recognized by the participating pre-service teachers, it appears that this particular intervention only partially met that goal, as it did not entirely translate to equitable FBEE.

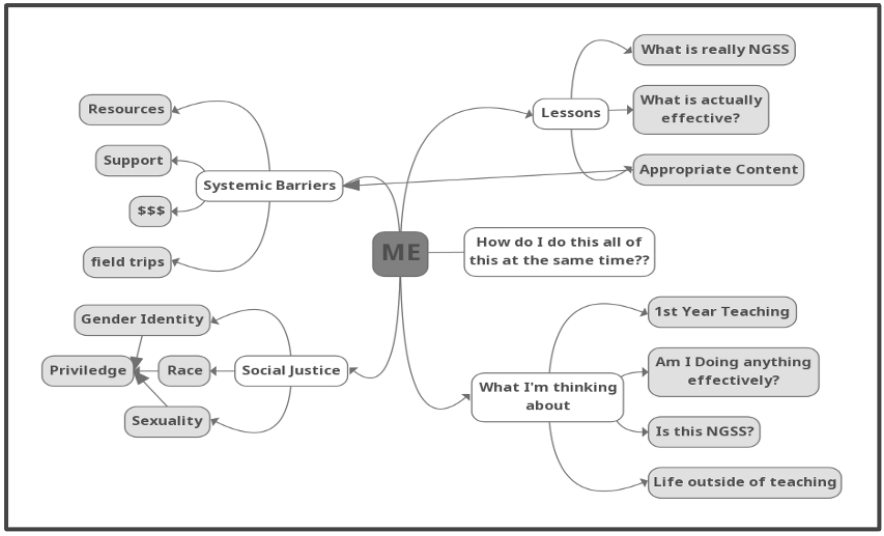
Environmental and field-based education need greater critical examination as we move towards designing equitable, anti-racist, hybrid spaces. This reflection was supported as the pre-service teachers were given space to reflexively negotiate, and then shift, their previous understandings of FBEE to more equitable FBEE. This retrofitting of newer views of equity into previous understanding of FBEE created visible contradictions which allowed the pre-service teachers to move with agency through the professional development program, voicing concerns and suggestions.

Figure 1

Focal Pre-Service Teacher's Concept Maps



(A)Cheyanne's Concept Map



(B) Sandy's Concept Map

Table 1.

Program Pre-service Teacher Information

Name	Undergrad	Interest in Science	Teaching Philosophy	Thoughts on Field-based Education	Placement/ CT
Sandy	Public University in CA Major: EEB Cal Teach	As a way to help community; Ecology interest sparked by Pokémon	Help develop a good society; Being authentic	Authentic engagement with content; learn respect for nature; grounding	High School; Novice Teacher with minimal experience in FBEE
Cheyanne	Private Christian College in CA Major: Education Minor: Environmental Science	Grew up in area with access to natural spaces	Developing Positive Character Traits and Respect	Invaluable; Develop richer connection to place	Middle School; CT with many years of experience teaching and an expert in utilizing FBEE in classroom

Table 2.

Focal Pre-service Teacher Extended Background Information References

Name	**Demographics**	**Placement**
Maggie	Female; Caucasian	11-12th Grade AP Environmental Studies
Cheyanne	Female; Caucasian	6th Grade Science
Skip	Male; Caucasian	N/A (was not paired with CT associated with program)
Hilago	Male; Latino	6th Grade Science
Sandy	Male; Latino	9th Grade Biology

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