INFORMAL-FORMAL PARTNERSHIPS IN SCIENCE EDUCATION: THE ROLE OF EQUITY AND RELATIONSHIP BUILDING

By

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ABSTRACT

This dissertation aims to address frequent calls for partnerships between informal science learning spaces and formal K-12 science education (e.g. Bevan & Dillon, 2010; Hofstein & Rosenfeld, 1996; NRC, 2009; Stocklmayer et al., 2010) as well as how informal educators and organizations are or are not addressing issues of equity within these types of partnerships. Informal science education (ISE) as a field is very broad, including such activities and contexts as public and family trips to places like museums and nature centers, K-12 school field trips, engagement with science media and more. Although millions of people visit informal science institutions each year (NRC, 2009), there is inequity in who can access these science experiences and for whom the experiences are designed. Partnerships between ISE institutions and schools are one potential way of both enhancing and supplementing school science as well as increasing participation in informal science experiences. Though many scholars call for these types of partnerships, there is little agreement about what kind of features might contribute to a successful and productive partnership.

Another aim of this dissertation is to give a voice to informal science educators. Informal science educators (ISErs) are part of the science learning ecosystem but are often not considered in teacher education research. They come from a variety of educational backgrounds and therefore do not have common educational experiences. While a lot of teacher education research focuses on preservice teacher education programs and the potential of those spaces to work with future teachers to think about equity and social justice, there are not equivalent spaces where ISErs might engage in these same discussions. Therefore, it is important to see what kinds of knowledge and experiences ISErs have around DEI issues so that we might begin to think about the professional development needs they might have.

This work addresses these problem spaces in three related papers. The first is a theoretical exploration of informal-formal science education partnerships. Because such partnerships involve two separate institutions with their own objectives, cultures, histories, and communities, I decided to explore the idea of partnerships through the lens of Cultural Historical Activity Theory (CHAT), which specifically takes into consideration how culture and history may affect human activity. In this first paper I will explain why CHAT is a useful lens through which to think about partnerships as well as provide recommendations for how to create productive partnerships based on this theoretical framework.

The second manuscript is a narrative case study of a partnership in formation between a local park system and a public school within a large urban school district in a midwestern state from the perspective of two ISErs. This paper describes in detail the challenges and successes of creating a partnership between two very different systems and the learning that was required of the informal educators to work productively with teachers and students in an urban school context. I will show how CHAT played out in action for these educators including what aspects were instantiated in their work and what was missing that might have contributed to challenges they experienced.

The third and final manuscript is a survey and interview study with ISErs who work, at least in part, with K-12 students in urban areas. It focuses on their perceptions around issues of diversity, equity, and inclusion (DEI), what efforts they and their organization have made regarding DEI, whether their organizations are supportive or not when it comes to further efforts, and what barriers they feel exist to making change at their organization or the field

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INTRODUCTION

This dissertation aims to address frequent calls for partnerships between informal science learning spaces and formal K-12 science education (e.g. Bevan & Dillon, 2010; Hofstein & Rosenfeld, 1996; NRC, 2009; Stocklmayer et al., 2010). Throughout the past 25 years, scholars have consistently called for informal-formal science education partnerships. Although these terms can vary in definition, in this dissertation I will be using the term formal education to refer to education that occurs within the context of school and informal education to refer to education outside of schools. Within the literature, such calls generally urge for the bridging of the gap between formal and informal learning, for schools to reach out to informal science institutions, and for more partnership-focused research to provide a variety of learning experiences in science that together build a foundation of science literacy for youth. For example, one of the first calls for these types of partnerships came from Hofstein and Rosenfeld (1996) who argued for the integration of informal science learning into formal science learning to provide more variety in instructional methods for students when learning science. Bevan and Dillon (2010) described discussions by both researchers and policy makers who argued that bridging informal and formal science learning may make science more "engaging, authentic, and conceptually rich" (p. 167).

In the United States, since the publication of *A Framework For K-12 Science Education* (NRC, 2012) and adoption by many states of the Next Generation Science Standards (NGSS), scholars have pointed out that informal-formal partnerships could help address the ambitious science learning goals within the NGSS (NRC, 2015). Informal science education (ISE) experiences, such as outdoor education, museum education, and zoo and aquarium education, have the potential to supplement classroom science education to create a richer science learning ecosystem (NRC, 2015). This may be especially important in elementary grades where there has

been a decline in time spent on science learning, which in turn has affected student preparedness for science in high school and beyond (Blank, 2013).

The Next Generation Science Standards are based on the *Framework's* three-dimensional science learning, focusing on disciplinary core ideas, cross cutting concepts, and the use of science and engineering practices (NRC, 2012). Scholars have suggested that informal science institutions have the potential to enhance this three-dimensional science learning, particularly in student development of science practices (Habig & Gupta, 2021). Outside of the United States, in 2015 the Council of the European Union and European Commission (2015) released a joint report that noted validation and improvement of non-formal and informal learning opportunities as a priority area as it would promote lifelong learning, "focusing on learning outcomes for employability, innovation, active citizenship and well-being" (p. 32).

ISE experiences are also influential in developing general science interest in youth (Ayar, 2015; Khanaposhtani et al., 2018; NRC, 2009) as well as interest in future science careers (Joyce & Farenga, 1999, NRC, 2009). Parts of this dissertation will focus specifically on informal science educators (ISErs) who teach in the outdoors. Outdoor education (OE) experiences in particular can have positive effects on emotional and cognitive development among youth, such as reduced stress (Wells & Evans, 2003) and increased attention span (Taylor & Kuo, 2009).

ISE institutions exist in many different contexts and cater to many different audiences. ISE as a field is very broad, including such activities and contexts as public and family trips to places like museums and nature centers, K-12 school field trips, engagement with science media and more. Although millions of people visit informal science institutions each year (NRC, 2009), there is inequity in who can access these science experiences and for whom the experiences are designed. For example, one study on ISE visitation in the UK found that visitors to informal

science centers were a majority middle-class and from White British backgrounds (Dawson, 2014b). For the general public, there are many barriers to accessing ISE, including cost of entry and transportation, as well as a need for leisure time to take a visit to an informal institution (Dawson, 2014b). However, even with barriers to physical access removed, research has found that historical marginalized groups (i.e., BIPOC individuals, women, LGBTQ+ individuals, and disabled individuals) do not see themselves represented in these informal spaces and do not feel like they belong (Dawson, 2014a; Dawson, 2014b).

In addition to this problem of physical representation, science center exhibits often have an absence of linguistic and epistemological representation in their use of primarily English signage and Western Modern Science (Mutegi, 2011) represented as the ideal (Dawson, 2014a). In a UK study, Dawson (2014a) followed Asian, Somali, Afro-Caribbean, Latin American and Sierra Leonean community members as they engaged with programming at informal science centers. Dawson (2014a) describes her participants as having to engage in extra emotional and cognitive labor in order to navigate the different exhibits and engage with the content. This led to participants being frustrated and feeling othered by the spaces they were in. Although ISE has been shown to have positive effects on youth interest and engagement in science practices, historically marginalized individuals are often excluded from these experiences. Creating partnerships between public schools and informal science institutions has been suggested as one way to address this and provide a way for schools to connect with community institutions to promote diversity and equity through community engagement (Lee et al., 2014).

Many of the efforts to address equity in ISE have focused solely on increasing access and not on addressing underlying systems that have led to ISE upholding a dominant narrative of Whiteness (Gosalvez, 2020). Focusing solely on access is misguided, because it assumes that

informal institutions are already providing relevant resources, learning opportunities and perspectives for all visitors, which we know is not the case for those that feel othered in informal science spaces (Feinstein and Meshoulam, 2014; Philip and Azevedo, 2017).

In this dissertation I attempt to address the above problems in two ways. The first is to use theory to think about informal/formal science educational partnerships as well as examine a particular partnership as a case study to learn about how these types of partnerships may be created and sustained. The second is to talk to informal science educators in order to get their perspectives on Diversity, Equity and Inclusion (DEI) and how their organizations support or do not support efforts around increasing equity in ISE, particularly in trying to shift the focus from solely focusing on access to also addressing the issue of belonging in ISE spaces. I will do this in a series of three related papers.

The first manuscript is a theoretical exploration of partnerships between informal science education and school science education. Past research on such partnerships has primarily focused on youth outcomes and are designed as evaluations of programs that brings together informal and formal science education. This research has shown positive effects for youth as well as teachers who participate in informal science experiences. However, very few of these papers explicitly addressed how theory might inform the creation and implementation of partnerships. Because such partnerships involve two separate institutions with their own objectives, cultures, histories, and communities, I decided to explore the idea of partnerships through the lens of Cultural Historical Activity Theory (CHAT), which specifically takes into consideration how culture and history may affect human activity. In this first paper I will explain why CHAT is a useful lens through which to think about partnerships as well as provide recommendations for how to create productive partnerships based on this theoretical framework.

The second manuscript is a narrative case study of a partnership in formation between a local park system and a public school within a large urban school district in a midwestern state from the perspective of two ISErs. This paper describes in detail the challenges and successes of creating a partnership between two very different systems and the learning that was required of the informal educators to work productively with teachers and students in an urban school context. In particular, the educators experienced many challenges prior to even entering a school building because of their lack of knowledge regarding the system of the school district, including the various levels of oversight within the district and how science teaching is enacted within the classroom. Through conversations with the informal educators as they navigated the district permissions, encountered red tape, and finally were able to enter the classroom and begin their programming, I will show how CHAT played out in action for these educators including what aspects were instantiated in their work and what was missing that might have contributed to challenges they experienced. In addition, through their participation in a summer professional development alongside district teachers, the ISErs learned a lot about the urban teacher experience and developed a better understanding about the system the teachers worked within, the community of the schools, and the division of labor within the system which increased their capacity to be effective in their partnership.

The third and final manuscript is a survey and interview study with ISErs across the same midwestern state who work, at least in part, with K-12 students in urban areas. It focuses on their perceptions around issues of diversity, equity, and inclusion (DEI), what efforts they and their organization have made regarding DEI, whether their organizations are supportive or not when it comes to further efforts, and what barriers they feel exist to making change at their organization or the field. Research has shown that as a field informal science education faces large equity

challenges, with a large majority of visitors to informal sites, both school groups and family/public groups, coming from White, affluent communities (e.g. Dawson, 2014). Studies have shown that there are challenges around access to informal sites of learning, but also that historically marginalized individuals (i.e. BIPOC individuals, women, LGBTQ+ individuals, and disabled individuals) do not feel represented or welcome in these spaces (e.g. Dawson, 2014a; Philip and Azevedo, 2017; Tal, 2020; Waite et al., 2021). Prior research suggests that informal science education institutions and educators have varied conceptions of equity and therefore actions around equity are varied (Philip and Azevedo, 2017). In addition, addressing equity is not often a priority in informal science institutions and, therefore, usually efforts are only made when funding is granted for specific projects that once again typically focus on access (Feinstein and Meshoulam, 2014). In this study I found most ISErs in this study cared deeply about issues of equity including access, participant belonging, and staff diversity, but the actual efforts that they mentioned that their organizations had undertaken were most often focused on access and not addressing any underlying systemic issues. Some barriers to implementing change that ISErs noted were a lack of financial or staff resources, a lack of support from their organizations or people in leadership roles, and a lack of opportunities around further education regarding DEI. Based on the information that the ISEr participants shared with me, I will discuss some possible next steps for the field to take to address some of the most prevalent equity issues.

PAPER 1

CHAT Theory as a Framework for Understanding and Addressing Informal/Formal Science Education Partnership Challenges

People learn about the natural world both in school and out of school. Out-of-school science learning occurs at home with families, and in informal science programs at zoos, museums, nature centers, summer camps, among other sites. Several scholars have suggested that learning outside of school is important not only for generating excitement about science, but also for developing science literacy, or the ability to engage with science content and use it in personal decision making (e.g. Bybee & McCrae, 2011; Hurd, 1998; National Research Council, 2009). There have been many calls for partnerships between informal learning environments and formal education (e.g. Hofstein & Rosenfeld, 1996; NRC, 2009; NRC, 2015; Stocklmayer et al., 2010), to provide more coherence between science learning in and out of schools. Since the implementation of the Next Generation Science Standards (NGSS), scholars have suggested that community and informal science partnerships could be a way for schools to achieve the ambitious science goals of the NGSS (NRC, 2015).

Literature regarding such partnerships is often limited to the context and claims of that partnership. Most studies on informal and formal partnerships are specific program evaluations, measuring youth or teacher outcomes such as change in science attitudes or content knowledge, and thus lack predictive arguments that could be generalized to other situations or contexts. A stronger theoretical foundation could inform more broadly what elements should constitute a productive partnership between informal and formal educators, what potential tensions might arise, and how to work past them.

Literature on partnerships often offers varied recommendations about how partnerships might form, what might contribute to the sustainability of such partnerships, and the roles that teachers, informal educators, and researchers might play. For example, one common type of partnership between informal and formal science education is teacher professional development (PD) at an informal science institution (e.g. Goodale and Sakas, 2019; Kisiel, 2009; Melber & Cox-Peterson, 2005; Miele et al., 2010; Pecore et al., 2013). In this type of partnership, informal science educators are often missing from the focus of the research or are portrayed as having limited roles; they are typically treated as providers of content knowledge or as site coordinators for other experts who lead content-based PD. In this paper I review the current state of research on informal and formal science education partnerships, identify the few theoretical frameworks which have been proposed to account for how partnerships might form and be sustained, and then discuss how one particular theory--Cultural Historical Activity Theory or CHAT--might serve as a useful framework with which to both analyze partnerships between informal and formal education as well as design such partnerships.

Informal-Formal Educational Partnerships

In order to make the claims about needing a stronger theoretical foundation, I first discuss the cognitive and affective benefits of informal science education that have been noted in the literature to establish why having educational opportunities in science outside of school is important. Then, I outline the calls for partnerships between informal and formal science education and why these partnerships are important. Next, I draw from empirical studies on such partnerships to highlight the variety of models that exist and the lack of consensus about partnership formation and sustainability. Finally, I discuss how the focus of these studies on partnerships is most often on content-specific outcomes and not on critical processes, a problem

that could be addressed, at least in part, by making use of appropriate and powerful theoretical frameworks.

Benefits of informal science education

Informal science-rich settings have enormous potential for both cognitive and affective engagement with science. Research on the value of science learning in informal settings demonstrates benefits such as increased student interest in science (Ayar, 2015; Khanaposhtani et al., 2018; NRC, 2009) and interest in future science careers (Joyce & Farenga, 1999, NRC, 2009). Sites of informal science learning often utilize "free-choice" learning (Falk & Dierking, 2010), which gives youth the opportunity to choose what they are interested in learning more about; this in turn can contribute to increased engagement. In particular, Falk and Dierking (2010), in their discussion of informal science learning, argue that free-choice learning represents the large majority of science experiences for North Americans, both for school-aged children and the general public. Yet most of the discussions regarding science education reform focus on classroom learning, which most often differs greatly from that which occurs in informal spaces (Falk & Dierking, 2010).

In 2009, the National Research Council published a framework built on informal science learning literature that accounted for the state of knowledge in the field as well as suggestions for future research. By reviewing the literature on the benefits of informal science learning, the authors outlined six "strands of science learning" (p. 294) which state that through effective informal learning experiences "Learners in informal environments:

1. Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

2. Come to generate, understand, remember, and use concepts, explanations, arguments, models and facts related to science.

3. Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.

4. Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.

5. Participate in scientific activities and learning practices with others, using scientific language and tools.

6. Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science." (NRC, 2009, p. 294-295)

These six strands of science learning in informal environments illustrate both the affective and cognitive benefits that are possible in informal science spaces. Just as importantly, these benefits of informal science learning overlap with many of the goals for school-based science learning as outlined in *A Framework for K-12 Science Education* (NRC, 2012). For example, the focus on learning about natural phenomena and using scientific practices (such as modeling, constructing explanations, engaging in scientific argumentation, etc.) can also be seen in the *Framework* and Next Generation Science Standards (NRC, 2012).

Calls for partnerships

Literature over the past 25 years indicates that scholars have called for partnerships between informal and formal science institutions. These calls generally urge for a closing of the gap between formal and informal learning, for schools to reach out to informal science institutions, and for more partnership-focused research in order to provide a variety of learning experiences in science that together build a foundation of science literacy for youth.

For example, Hofstein and Rosenfeld (1996) argued for the integration of informal science learning and formal science learning. Because there is a wide range of different activities that fall into the former category, the authors focused on reviewing the literature from five specific categories: 1) school-based field trips; 2) student projects; 3) community-based science youth programs; 4) casual visits to museums and zoos; and 5) the press and the media. These different modes of informal science learning were organized by the degree of free choice they offer. They found that there was far more research on integrating school-based field trips and student projects into formal science than the other categories and argued for more research on how/whether such integration supports student motivation in science as well as provide a variety of science experiences for youth (Hofstein & Rosenfeld, 1996).

More recently, the National Research Council (2009) published a report that also calls for partnerships between informal and formal science education. Although the report focuses more on the benefits of informal spaces in and of themselves, they call for further research into how schools and informal science institutions might support each others' work. However, despite echoing previous calls for informal and formal educators to work together, the authors call for careful consideration of the unique affordances of each site and warn against simply applying what we learn from one environment to another. For example, the report echoes research that calls for better assessment of informal science learning, but the authors also argue that school-based assessment measures are not appropriate for informal learning environments and warn against educational researchers using similar assessment methods that are used in schools for this purpose. Instead, partnerships need to allow for both environments to retain their unique features and affordances, with educators developing an appreciation for the unique opportunities available both in classrooms and in informal educational settings. For example, the authors of

this report do not necessarily suggest that a school incorporate more informal pedagogical techniques or that an informal educational institution incorporate classroom pedagogy. Instead, according to this report, an ideal partnership would retain the individual benefits of informal and formal learning environments while also promoting coherent learning between the two.

Additionally, since the National Research Council published the *Framework for K-12 Science Education* (NRC, 2012) and many states have adopted or adapted the Next Generation Science Standards (NGSS), there have been additional calls for partnerships in order to accomplish this new ambitious view of science learning (NRC, 2015) as well as provide a way for schools to connect with community institutions and promote diversity and equity through community engagement (Lee et al., 2014). Although the *Framework* itself does not discuss informal science education beyond noting its importance, in the *Guide to Implementing the Next Generation Science Standards* (NRC, 2015), the NRC recommends that formal science education leaders should work to form partnerships with informal education centers, community programs, and businesses:

> To increase the capacity of the system to reach this vision of the Framework and the Next Generation Science Standards (NGSS), all of the stakeholders in science education will need to work together. The plans will need to involve a wide range of people and institutions, including places that provide informal learning opportunities; scientists and engineers working in business or higher education; science education researchers; and science-rich institutions and organizations, as well as parents and others in the community (NRC, 2015, p.10).

The *Guide* also discussed how these partnerships should be mutually beneficial. The authors claimed that the *Framework* would help to provide common language that would assist

in forming these types of partnerships and develop a shared vision for science education. This *Guide* provides an interesting contrast to the Hofstein and Rosenfeld (1996) article, despite echoing a similar call for educators to work across contexts. While Hofstein and Rosenfeld (1996) argued that classrooms should incorporate more informal learning pedagogies because of the documented benefits for student learning, the NRC (2015) argued that informal science institutions should align themselves with the NGSS, standards built around classroom learning. However, in a survey of informal science educators, Hunter et al. (accepted for publication) found that ISE's main motivation for aligning their programming with the NGSS is for teacher and administrator buy-in and that they do not necessarily feel it is aligned to the mission of informal science education otherwise. So, this goal of NGSS providing a shared language and vision for science education may not be shared by informal science educators.

Looking across these calls for partnerships, we see a focus on the importance of informal and formal educator collaboration to promote coherent science learning. The first call for this type of partnership was published 25 years ago and the existing literature in the field still does not provide a clear vision of what these partnerships might look like and what helps them to succeed. In the following section, I discuss some of the empirical studies on partnerships that appear in the literature, specifically focusing on the expectations of informal and formal educators in these partnerships.

Roles of Teachers and Informal Educators (IEs)

The varying roles that classroom teachers and informal educators (IEs) play reveal the different frameworks upon which partnerships are built. Some of the ways partnerships are formed and investigated suggests an implicit and unequal distribution of power and voice between participants and researchers. The literature often takes a deficit lens, focusing on what

one community of educators is lacking that the other might be able to provide instead of what and how they might learn from and with each other. These power differentials--both explicit and implicit--can make partnerships difficult to sustain in ways that are simultaneously inclusive, productive and consequential.

IEs as Professional Development Facilitators for Teacher Learning

One of the most common forms of partnership described in the literature involves teacher professional development (PD) led by informal educators. Common sites for this type of partnership are museums (e.g. Melber & Cox-Peterson, 2005; Miele et al., 2010), zoos (e.g. Pecore et al., 2013), and aquaria (e.g. Goodale and Sakas, 2019; Kisiel, 2009). Many studies in these contexts are based upon the premise that teachers lack some specific science content knowledge and that IEs are able to provide such knowledge, with the ultimate goal being that teachers incorporate what they learn into their classroom instruction (e.g. Goodale and Sakas, 2019; Melber & Cox-Peterson, 2005; Miele et al., 2010; Pecore et al., 2013). The other commonly expressed goal of this type of partnership is to give teachers a new experience that increases their excitement about and confidence in teaching science (Melber & Cox-Peterson, 2005; Pecore et al., 2013).

As noted above, these studies often discuss teacher knowledge through a deficit lens, focusing solely on what they are lacking. For example, Pecore et al. (2013) studied science content knowledge and attitudes of teachers attending a neuroscience-focused PD program led by zoo personnel alongside researchers. Despite an observed increase in science content knowledge, the teachers' scores overall were lower than the researchers expected. However, instead of suggesting a change in the PD content or approach, the researchers suggested that the material would be more appropriate for those teaching honors rather than general science courses. They

also suggested that teachers' greater age and experience might have been responsible for the lack of an observed increase in science attitudes, again putting the onus on the teachers for the lack of effectiveness of the implemented PD. There is no evidence that the researchers engaged teacher participants in a discussion, for example, about their views of the content, including their perceptions of its relevance to the particular contexts in which they worked.

In addition, there is little discussion about how and why the partnership was designed in a particular way. For example, Pecore et al. (2013) did not discuss the benefits of learning at the zoo that was the site of the PD beyond that teachers reported it was enjoyable and interactive. In fact, the location of the program was not explicitly linked to the scientific ideas that were the focus of the PD; the only reason the zoo was chosen as the PD site was because the authors felt it would have a positive motivational effect on teacher participants and would increase their positive attitudes towards science. In the end, however, the authors found that there was no change in science attitudes due to the PD. In their study of a museum-led PD, Melber and Cox-Peterson (2005) also did not consider the preparation or teaching of the informal educators who designed and led the PD at the museum; the expertise of these PD leaders was apparently simply assumed to be both relevant and sufficient. Although the author claimed to be investigating an informal-formal partnership, only the formal educators were the focus of the analysis and there was no theoretical discussion of why the PD was designed the way that it was or how the authors' claims were generalizable to a broader audience.

Informal Educators as Guides

Another category of research on informal and formal science education partnerships is on programs where informal educators lead field trip experiences for students. This area of research is typically focused on how informal educators teach (e.g. Lavie Alon & Tal, 2017a) or, more

frequently, the impact of such experiences on youth cognitive or emotional outcomes (e.g. Bamberger & Tal, 2008; Davidson et al., 2009; Lavie Alon & Tal, 2015). In these studies, ISEs lead the experience, and classroom teachers are often not mentioned or are reported to act as bystanders to the program, solely focusing on crowd control. In fact, prior research that has examined the roles teachers play in informal learning has found that teachers are often uncertain of what role they should play during field trips (Davidson et al., 2009; Lavie Alon & Tal, 2017b), clearly suggesting that these roles have not been clarified prior to the experience.

Several of these papers also discuss educators through a deficit lens. In a study on zoo field trip experiences, Davidson et al. (2009) stated that "if teachers merely rely on a zoo educator to lecture students, or give them a worksheet, student learning will most likely be shallow and fleeting" (p. 138). This claim seemed to stem from statements that students made saying that listening to the zoo educators talk was the most boring part of the field trip. The focus of studies about field trip experiences do not often consider the strengths that both informal and formal educators might bring to the experience. The need for ongoing professional learning of both formal and informal educators and the appropriate design of partnership opportunities which call on the strengths that each bring in the support of the scientific understanding of youth is a stance taken by several researchers more recently. For example, Lavie Alon and Tal (2017a) studied how Outdoor Educators (OEs) used the natural environment while teaching as well as how they communicated with students and the pedagogy they used in their teaching. Although not specific about the role that teachers played in these field trips, the authors do discuss the importance of communication between teacher and outdoor educator and teacher involvement in field trips in another paper (Lavie Alon & Tal, 2017b). In the latter study, they identified a large variety of ways that teachers are more or less involved in orchestrating such experiences and the

positive impact it has on children's learning when they are more substantially involved.

Mutually Beneficial Partnerships

A smaller collection of studies illustrates how both informal educators and formal classroom teachers play a mutually beneficial role in the partnership. In one study, Weiland and Akerson (2013) studied a fifth-grade teacher and informal science educator who co-planned and co-taught a life science unit in the classroom. This study specifically focused on the roles that each educator played in the partnership as well as youth outcomes from the unit. One of the noted reasons for the success of this particular partnership was that the teacher and informal educator had a previous relationship and had already built rapport. One limitation of this study is that the partnership was not explored from the beginning and the shared goals and trust between the educators was already built prior to the study.

One particularly interesting outcome of the study was the roles that each educator played in the partnership. These roles were both observed by the researchers and discussed in interviews with the educators. The educators both noted that the informal educator had specific science content knowledge and the formal educator had knowledge of the children in the classroom and was therefore able to make connections to students' prior experiences. Both the teacher and informal science educator were positioned as having knowledge that the other could benefit from, something that is starkly different from many of the papers discussed above.

Another example where teachers and informal educators both contributed substantially to the partnership occurred between an aquarium and urban elementary school (Kisiel, 2009). The author discusses in depth certain structural components that were necessary for this partnership to be successful, such as the school being walking distance from the aquarium and being given free entry to the aquarium. In addition, Kisiel (2014) describes the efforts that were made to

encourage a sense of community between the two separate sites of learning. Aquarium educators were assigned a grade level so that they could get to know students and teachers more closely. They also visited the classrooms to do presentations and were encouraged to attend other school events. The two partners prioritized long term relationship building.

Theoretical Lenses on Informal-Formal Partnerships

The partnerships I explored above are primarily studies using program evaluation methods without strong connections to theory which might assist in making predictive and generalizable arguments. The use of a theoretical lens in this case would allow researchers to explain, predict, and understand how partnerships form and are sustained over time, adding to the general knowledge base. In other words, there is a need for general principles that might guide the people and the work. Communities of Practice (CoP) and Cultural Historical Activity Theory (CHAT) are two theories that have been suggested as potentially useful in this type of research. In one illustrative research paper, CoP (Lave and Wenger, 1991) was used to investigate a partnership between a school and an aquarium (Kisiel, 2014). However, there are limitations of using CoP to explore these types of partnerships which I will elaborate on below.

Communities of Practice

A Community of Practice (CoP) is defined by Lave and Wenger (1991) as a "set of relations among persons, activity, and world, over time and in relations with other tangential and overlapping communities of practice" (p. 98). Within a CoP, there is a common shared practice, and learning occurs when individuals participate in that practice. For example, communities of practice could be used to understand a learning community of teachers engaging in work to develop their practice around engaging students in science investigations. Experts within a community are often called old timers and those joining the community are newcomers. Through

what Lave and Wenger (1991) call legitimate peripheral participation, newcomers may gain more expertise within the community and eventually become old timers themselves. Learning within a CoP inherently involves social interaction with others in the community and through this regular interaction individuals will learn the norms and values of the community from more knowledgeable others and be more able to participate in a legitimate way, as defined by the old timers in the community.

Educators often have different ideas about their role in teaching science depending on their context (e.g., formal, informal, or others) and its particular constraints and affordances for teaching science. These may account for, at least in part, varying motivations for becoming a part of a CoP and can lead to tensions for participants as the partnership develops. Kisiel (2014) uses a CoP lens to discuss these tensions while investigating a partnership between a school and an aquarium. The author argues that this framework helps to explain some of the common challenges that emerge when two different communities overlap as well as how to move past the potential tensions to create a sustainable partnership.

The aspects of CoP that Kisiel (2014) focuses on are what Wenger (1998) calls mutual engagement, joint enterprise, and shared repertoire – in other words, the actions that community members share, the goals or requirements of the practice negotiated informally by community members, and the mediating resources, tools, language, etc. used by the community. Kisiel (2014) discusses the aquarium and school as two separate communities of practice that came to overlap during the collaboration. The author found that he could determine that an overlap was happening through these three emerging properties being shared among the aquarium educators and teachers: mutual engagement, joint enterprise, and shared repertoire.

One of the challenges of using CoP as a theoretical framework with which to look at learning within a partnership between two different organizations is that the unit of analysis for CoP has historically been the individual community member. Wenger (1998) did move away from his earlier apprenticeship model (Lave and Wenger, 1991) to begin thinking of organizational learning, and some scholars have used CoP to analyze organizational learning (e.g. Brown & Duguid, 1991). However, empirical research on this is "thin", and the dynamic processes that unfold when two communities decide to work together for a new purpose has not been empirically demonstrated, particularly where there is no recognized expert or "old timer(s)" with respect to the particular practice identified as the primary goal.

When discussing collaborations among multiple communities, CoP assumes that the two separate communities will come to overlap in some way and come to have some joint enterprise and shared repertoire. However, this may not be the case in a partnership where the two organizations hold different roles in a collaboration and may not need to overlap much if at all. In addition, CoP assumes an individual or group of individuals holds some expertise that others are working toward. Wenger (1998) states "Certainly, in order to legitimize the community as a place for sharing and creating knowledge, recognized experts need to be involved in some way" (p. 7). However, when two (or more) organizations, or groups of educators, come together to solve a novel problem, they are producing new knowledge for which there may be no expert and the CoP lens may be inadequate in identifying the dynamics of the processes which are necessary to support a partnership which is both effective and long-lasting.

Engeström (2007) offers further critique of the ahistorical, acontextual use of CoP. He claims that neither Lave and Wenger (1991) or Wenger (1998) "situate their communities of practice in the history of real societies and patterns of organizing work" (Engeström, 2007. p.

43). Instead of the implied linear movement from novice to expert in CoP, Engeström (2007) compares complex human activity to mycorrhizae, with "horizontal and multidirectional connections," that is both "a living, expanding process… and a relatively durable, stabilized structure" (p. 48).

Cultural Historical Activity Theory

Cultural Historical Activity Theory (CHAT) is a theoretical framework which addresses some of the mentioned limitations of CoP and might serve as a more productive lens with which to examine partnerships between informal and formal science educators. It does so by treating each partner as a separate activity system located in historical context. The third generation of CHAT in particular (see Engeström, 2001), which is an expansion of Activity Theory (Leont'ev, 1978), examines learning occurring between a minimum of two systems jointly producing new knowledge.

A single activity system (the object of study in Activity Theory) includes the subject, community, and the rules of that community. At first that may sound similar to a community of practice, however, instead of being situated around a shared practice, it is situated around the context in which a human activity occurs, including the subject of a human activity, the object, the broader community, the division of labor within that activity system, the explicit and implicit rules, and the mediating artifacts (Engeström, 2001). For example, a science class on a field trip might be thought of through the lens of an activity system, with the teacher as the subject who has a desired outcome of helping their students learn some aspect of science (the object) through mediating artifacts like worksheets, the textbook, lab experiments, etc. The community extends beyond the teacher to include the administration, the students, the parents, etc. A science class likely has specific rules in place as well as implicit customs or norms that members of the class

follow. In a more didactic, teacher-centered classroom setting, the division of labor might be defined as teachers teach and make the rules and students listen and learn. Of course, different science classes, different schools, different school districts (depending on the scale at which we are considering the activity system) would have different mediating artifacts, communities, rules, and divisions of labor based on the contexts they work within.

In the third generation of CHAT, activity theory is taken one step further by considering more than one interacting activity system (Figure 1). Thus, if a science classroom on a field trip is a single activity system, an interacting activity system might be a nature center providing guided instruction for the students and a partnership between these two systems could be examined using CHAT. In addition, the theory explicitly considers how history and culture may have shaped each activity system, which in turn provides a lens for understanding how differing epistemologies of these systems might have come to be. In other words, "the participants carry their own diverse histories, and the activity system itself carries multiple layers and strands of history engraved in its artifacts, rules and conventions" (Engeström, 2001, p. 136).

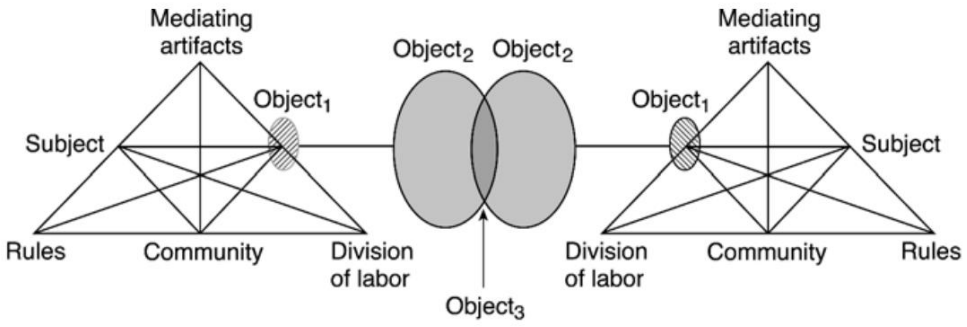

Figure 1: Two interacting activity systems in CHAT. (Engeström, 2001, p. 136)

In CHAT, tension between systems is explicitly considered. In fact, Engeström (2001) suggests that the most learning occurs in times of tension through what he calls expansive

learning. He states "A conflict of motives is the mother of all expansive learning" (Engeström, 2017, p. 359). Expansive learning is defined by Engeström (2001) as the creation of new knowledge (in contrast to someone acquiring already existing knowledge) and therefore, unlike within a Community of Practice, there are no experts. Two activity systems that come together purposefully to solve a novel problem or collide accidentally when an unknown problem arises, must co-create knowledge through a process Engeström (2001) calls *knotworking* which involves the negotiation of tensions and conflicts between activity systems. No system in this case has the expertise to solve the emerging problem on their own. Although Kisiel (2014) does discuss the idea of tensions between the school and aquarium through communities of practice, tension and conflict is not inherently part of CoP. In CHAT, this idea of learning through conflict is a valued and named process that is extremely important when two organizations with different goals, histories and cultures are working together.

As tension and conflict are negotiated, the subjects of participating activity systems may evolve and learn to collaborate through shared practices in response to novel problems in a process called co-configuration (Engeström, 2004). "Co-configuration requires flexible 'knotworking' in which no single actor has the sole, fixed authority" (Engeström, 2004, p. 13). Learning through co-configuration occurs between and within "loosely interconnected activity systems and organizations… representing different traditions, domains of expertise, and social languages" (Engeström, 2004, p. 16). In other words, as different organizations with different goals, norms, and histories work together to solve a problem, co-configuration occurs as they learn to collaborate and develop some shared practices or merge some existing practices. It does not occur when one partner has authority over the other or tries to force the other to use or adopt their practices.

Use of CHAT in Science Education

Science education scholars have implemented CHAT primarily as a lens with which to look at classroom learning or teaching. In a literature review, Roth et al. (2009) discuss the specific affordances of CHAT to break down traditional dichotomies often present in science and science education. For example, in thinking about mediated human activity, CHAT does not differentiate between the individual and the collective actions, and therefore views human action within the context of the social world (Roth et al., 2009). Plakitski (2013) also argues that CHAT views the world in a way that could push against common positivist paradigms in science and science education. Specifically she posits that the application of CHAT in science museum education fits with the social role museums often play within the informal science education space (Plakitski, 2013).

Recently, Rutt and Mumba (2022) used CHAT to examine preservice teachers (PSTs) implementing science and literacy integration. They found that CHAT was a useful framework to "highlight the socially and historically created contexts in which PSTs are teaching and to make visible how the mediating elements of those contexts support or contradict movement toward the desired outcome." This is an important aspect of preservice teacher learning because the classroom context does not always match the instruction that is given in university teacher preparation programs. Understanding preservice teachers' decisions as part of an activity system provides important context for teacher educators on how and why PSTs make the decisions they do in the classroom.

CHAT has been used to examine certain aspects of educational partnerships. Stroupe, Caballero, and White (2018) used CHAT to look at student epistemic agency during a collaborative moth research project between a classroom and an entomologist. The authors found

the idea of co-configuration within CHAT to be of particular use for this project. In the Stroupe et al. (2018) study, the entomologist, teacher, researchers, and students were all engaging in co-configuration throughout the unit and as they figured out their roles in the moth research, particularly promoting students' epistemic agency in the research. Co-configuration allows for joint creation of epistemic practices, rather than an expert (in this case the entomologist) deciding what practices and knowledge are to be adopted for legitimate participation (like in a CoP).

A modification of CHAT has been used when considering partnerships between informal and formal education more broadly. Fallik et al. (2013) proposed a model for bridging the gap between in-school and out-of-school science learning using CHAT. They argued that bridging informal and formal learning does three things: "1) increases student motivation for learning; 2) expands student conceptions of learning and knowledge; and 3) develops new student skills and abilities" (p. 70). Their rationale for creating a model for these partnerships is similar to what I have found while reviewing the literature; the vast majority of studies on partnerships are set within a specific context and "do not take into account all of the components of the issue" (p. 75). In order to create the model the authors proposed, they first identified both common and differing areas of concern between informal and formal learning, then created what they called "basic bridging principles" (p. 76), and then suggested some practical steps that educators can take when attempting to bridge the two contexts.

Identifying common and differing areas of concern between informal and formal learning has a clear connection to principles embodied by CHAT. If informal and formal learning represent two different activity systems, understanding differences and beginning the ongoing process of knotworking would be a key first step toward building a partnership. The bridging

principles that Fallik et al. (2013) proposed were "(1) Mutual recognition of the importance of bridging by both groups of educational staff; (2) Mutual acquaintance with the two curricula by both staff groups; (3) Preparation of students to reduce the 'novelty space' regarding the informal learning context; and (4) Ongoing dialogue between both staff groups" (p. 80). Some of these principles seem to be related to Engeström's (2001) idea of expansive learning (for example, ongoing dialogue would be a key component of knotworking), but the authors made no explicit connections to how these principles were derived from CHAT. In addition, the authors say that the model will be revised after being empirically tested, but unfortunately, there is no published record that this model was ever empirically tested or revised. As such, this paper provides some preliminary suggestions for how CHAT may provide a framework with which to look at these educational partnerships.

The previous uses of CHAT in science education and even in partnership research suggest that this may be a valuable framework for partnership work. Partnerships frequently occur when there is a desire to collaborate and solve new problems that each partner could not solve on their own. So how might the development and continuation of a partnership be informed by CHAT?

Recommendations for Research and Partnership Development

CHAT is a promising theoretical framework to examine how productive partnerships are created, sustained, and improved. CHAT may be particularly useful in partnership research because it considers multiple unique activity systems as they interact and considers the ways in which the sociocultural context of human activity affects the system or systems. For partnerships built between two distinct organizations (for example, a nature center and a school) CHAT would facilitate an examination of how the different organizations work together while also

making visible the features of each organization including mediating tools, community, norms, and division of labor (see Figure 1). In this section I outline five recommended steps to create a partnership informed by principles of CHAT: 1) outlining clear goals, 2) understanding each system, 3) articulating roles, 4) understanding and acknowledging histories, and 5) communicating and knotworking consistently through tension. These same recommended steps may be useful in developing a tool with which to analyze partnerships in educational research.

First, each system would need to outline their own goals as well as articulate the problem they are trying to solve by creating the partnership. Second, there would need to be foundational and ongoing conversations that would allow each partner to understand the system that the others are working within. (See Figure 1, Engeström's (2001) CHAT diagram for the different parts of an activity system that each partner would need to learn about their own organization and those of their partner organization). Third, together the partners would need to articulate the roles that they each will play in the partnership and continuously reevaluate if these roles might need to change in order to best accomplish the goals already discussed. The research discussed earlier shows that this negotiation of roles is often something that is not addressed prior to informal and formal educators working together; the lack of clear expectations leads to confusion about what roles each partner is supposed to play and potentially to disagreement and the development of unproductive tension. Fourth, partners should recognize the historical evolution of different systems which influences the varying structures of each institution and the varying beliefs or values that the subjects of each system might bring to the conversation. This acknowledgement would help organizations and individuals engage with the epistemologies of the other. Finally, CHAT requires consistent knotworking, co-creation of knowledge, and joint creation of

epistemic practices through co-configuration. Throughout the entire partnership, continuous communication is needed to address potential and real challenges and tensions.

After outlining the five steps below, I will provide a brief example of each based on a real partnership between a regional parks system and local public school, which I will call White Oak Parks and Morrison Academy respectively. Briefly, this partnership consisted of White Oaks Parks interpreters providing supplemental science lessons in the elementary science classrooms at Morrison Academy. This partnership is the subject of the case study I will describe in paper 2, so further details about how these features of CHAT are instantiated by this partnership as well as what features were missing can be found there.

Outlining Clear Goals

To reiterate, within CHAT, each activity system (represented in the case of an informal/formal education partnership by the different partnering organizations or educators) may have different goals, or objects (See Figure 1). These individual goals do not necessarily need to change or be modified to align with their partners' goals, but they should be addressed with an eye towards how each of the partners might accomplish their unique and common goals so that all benefit. Together, the partners will need to figure out how to accomplish these potentially varying goals, what goals might need to be prioritized, or potentially compromise in order to benefit all partners involved. One common type of partnership in the literature is that of professional development for formal educators led by informal educators. In the literature, communication prior to professional development is often not discussed so it is unclear what kind of communication occurs, if any. A lack of clear communication in turn leads to professional development that may not be considered useful to the formal educators or is even

sometimes irrelevant to their particular contexts. It is important to build in time for all parties to communicate about their goals if long-term, meaningful partnerships are going to be built.

In the partnership between White Oaks Park system and Morrison Academy, the parks employees came to the partnership with different goals than the teachers and administrators of the school. The park interpreters had the goals of increasing student and community knowledge of the parks and careers in the parks, increasing student science knowledge, and increasing student and teacher connections to nature. Administrators in the school had the goals of improving student standardized test scores, increasing teacher capacity for science teaching, and increasing teacher comfort level in leading outdoor investigations. Teachers in the school had some similar goals, but additionally had the goal of providing new and fun opportunities for their students. Although the partners had different initial goals for the creation of this partnership, they were able to communicate these goals and find ways to prioritize the goals that overlapped.

In the case of White Oaks Parks and Morrison Academy, none of the goals conflicted. Although they prioritized the goals that overlapped and that they felt were most feasible, they did not have to compromise or eliminate any goals. However, one could imagine a situation where not all goals are able to be addressed because they conflict or do not overlap at all. For example, if the parks system had goals that only addressed student learning, which would best be addressed through classroom instruction, and the school had goals that only addressed teacher learning, which would best be addressed through professional development, this partnership may not have worked or goals may have needed to shift in order for a partnership to be productive for all.

The Parts of Each System

An activity system is made of many different parts (Figure 1), all of which are important to make visible in order to get an accurate picture of the context that a partner works within. The subject, object, mediating artifacts, rules, community, and division of labor all play critical roles in the work of a system and partners should articulate these initially and revisit them as the work progresses. Some parts of the system are harder to see initially than others. For example, the rules and norms of an activity system can often be implicit or even hidden. Sometimes learning these rules and norms is not as simple as having a discussion about them, but requires longer term engagement in the community in order to understand how those rules and norms are enacted. Similarly, the division of labor in a system is not always explicitly stated. There may be hidden power dynamics because of a hierarchical division of labor that are important to understand.

Consider the partnership between White Oaks Parks and Morrison Academy again through the perspective of another feature of an activity system, its mediating artifacts and tools. Nature interpreters are often well versed in using field-based tools like water quality testing kits or insect collecting tools. Formal educators are more likely to be well-versed in classroom technologies, such as smart boards, online resources, or iPads. While the types of tools used by informal and formal educators often are very different from each other, all tools can contribute to science learning. In this partnership, White Oaks interpreters were coming into Morrison Academy classrooms, where they had to learn how to use the tools of the classroom that they were unfamiliar with. In addition, they introduced the classroom teachers to outdoor education tools useful for outdoor investigations which the teachers expressed excitement about using again in the future. Introducing partners to the tools that are used in different contexts in this

case, led to greater understanding of the resources available to partners and provided educators with ideas for how to incorporate those tools in their own context.

However, the interpreters at White Oaks Parks also had some challenges in coming to understand the system of Morrison Academy and the urban school district it is part of, particularly in figuring out the rules and division of labor within the district. Figuring out who to talk to and what permissions were necessary for even gaining access to the school took longer than the park interpreters expected. They learned that there was a lot of red tape that they had to get past and a hierarchical structure in the school system that they did not know how to navigate at first. Learning the rules of the public school system was essential for the partnerships' success and it was a long, difficult process. All systems operate with different constraints, so coming to understand the pressures that might come from an administration or community is an essential discussion to have and would provide understanding across contexts as well as establish a foundation for developing strategies for dealing with conflict.

Roles of Partners

As noted earlier there is often little agreement about the roles that informal and formal educators play in these types of partnerships. In most studies the issue of perceived or assumed roles has not been explicitly addressed. In a few studies, it has been reported that educators are unsure of the role that they are supposed to play, that they are excluded by others or that they exclude themselves from playing any active role. For example, while on field trips with guides or informal educators, teachers are often unsure of whether they should take a more active or more passive role (Davidson et al., 2009; Lavie Alon & Tal, 2016). In a partnership built using the principles of CHAT, the roles of each partner should be explicitly laid out and ideally both partners would contribute equally to the development of this new experience, for example a field

trip for students. These roles will likely come from the resources that each partner feels they bring to the partnership. For example, in the Weiland and Akerson (2013) paper regarding the informal educator and classroom teacher that co-designed curriculum, it was reported that educators knew the complementary strengths that they brought to the partnership because of their prior work together. The informal educator had specific science content knowledge that the 5th grade teacher wanted her students to learn, and the 5th grade teacher had knowledge of her particular students that allowed this science content to be taught in a more relevant and meaningful way. In a new partnership, where the educators do not have a similar long-term history working with each other, these roles will need to be purposefully clarified. Because each partnership is unique, there is no predetermined way that each particular partnership will best work or be sustained. The two (or more) systems must co-develop this knowledge. Of course, this type of partnership takes time and effort, which makes it more difficult, but also more likely to be sustainable.

In the case of the White Oak Parks interpreters and Morrison Academy teachers, this was a lesson they learned over time. Sam, one of the interpreters, felt she and the teachers she was working with did not initially discuss their roles in the classroom. She was afraid of "stepping on toes," or encroaching on the teachers' time and space. Specifically, the only time that they could meet regularly at first was during the teachers' planning periods, which Sam felt bad taking up more than about ten to fifteen minutes of. Due to a lack of communication, she didn't get clear information from the teachers about what they wanted her to do in the classroom. Her role had been articulated for her by the administrators that she had communicated with, but she and the teachers that she was actually working with had not had these important conversations. For the first several times she led activities in the classrooms, she felt like she was leading disconnected

activities that were fun for students, but not necessarily connected to the curriculum or goals that each system had. Eventually, she felt comfortable enough with the teachers that she scheduled more time to meet and discuss how things were going, including talking via phone and email more often. Through improved communication, she was able to better understand where the class would be in the curriculum on a given week, how the teacher felt she might be able to supplement that curriculum with the particular skills and tools she had, and felt like the activities she was able to lead were more relevant to the students' learning.

Understanding and Acknowledging Histories

The varying beliefs and values of educators working in different contexts comes from their unique histories and cultures. In addition, the organization of the system itself has been shaped by its history. Creating a partnership based on the principles of CHAT does not require one system to become more like the other. Instead, it allows for an understanding that when two or more systems with different histories and different goals come together, there will inherently be conflict and that conflict is important for expansive learning to take place. Engeström (2001) states

> Activity systems take shape and get transformed over lengthy periods of time. Their problems and potentials can only be understood against their own history. History itself needs to be studied as local history of the activity and its objects, and as history of the theoretical ideas and tools that have shaped the activity. (p. 136-137)

Human activity happens within a cultural context and the strength of CHAT is that it highlights the socially and historically created systems within which that activity occurs. Making visible these aspects of culture can be difficult, but is important for understanding. Teachers in the United States work within a system that has been shaped by historical and political decisions

that have prioritized increased test scores, common curriculum, and a lack of teacher freedom due to attempts at teacher accountability. A state park interpretation program on the other hand may have been shaped by its history first as stolen land from indigenous peoples (which may or may not be addressed within their educational programming), a history of prioritizing wildlife conservation education and wildlife management goals, and more recent shifts toward community engagement and outreach. It is critical that partners in different systems understand these different historical and cultural features of each other's as well as their own systems in order to develop a solid foundation for their collaborative work.

One way this learning occurred in the case of White Oaks Parks and Morrison Academy was through conversations Sam and Jessie, her supervisor, had with district teachers while participating in a professional development (PD). Both park interpreters did not have a deep knowledge of the urban public education system that teachers were working within. Through the PD, Sam and Jessie both expressed that they learned a lot about the day to day life of a teacher, the pressures they are under, the systems they work within, and the limitations that places them under sometimes. They connected this learning to history, realizing that these constraints were part of a culture developed over time and the power dynamics that existed within the district sometimes led to a lack of teacher agency. Sam and Jessie expressed that this helped them build empathy and understanding for the context in which the teachers worked and why they might prioritize different things than Sam and Jessie might.

Knotworking

The idea of knotworking is a continuous process of working through tension and conflict and should be integrated throughout the length of a partnership, not just prior to the start. This would require specific time to discuss how the partnership is progressing, whether partners'

goals are being met, and whether any changes are needed. Therefore, a partnership built on the principles of CHAT would likely need to be a longer-term partnership to allow for this necessary time to engage in knotworking. Engeström describes a single activity system as multi-voiced, or "a community of multiple points of view, traditions and interests" (p. 136). Within a single activity system there is more than one point of view and when considering multiple activity systems, these points of view multiply even further. These multiple points of view need to be named and negotiated. Although it is a complex and often challenging process, this knotworking is also where the most innovative ideas come from.

This process of continuously checking in and working through problems was difficult for Sam at first, particularly in the beginning when she was afraid to step on toes. This shows how long term relationship building is important for productive partnerships. Sam emailed me several months into the school year expressing that she felt like she had connected better with one of the teachers through a mutual love of football. They started talking about football games via email and text and she started feeling more comfortable communicating with him and checking in about how he felt things were going in the classroom as well. This led to better communication overall and Sam felt like because they were able to be more honest about how things were going and give each other constructive feedback, she was better able to connect the lessons she was leading with curriculum, plan better alongside the teacher, and both systems' goals were better able to be addressed.

Conclusion

The five recommendations described above based on CHAT are a first step to thinking about how theory might inform and be applied when creating educational science partnerships, something that has been called for in research. The following paper will explore one such

partnership, telling the story of White Oaks Parks and Morrison Academy in more detail and connecting their work to the principles of CHAT to see how this theoretical work holds up empirically.

In addition, future research using CHAT as a tool to evaluate current partnerships and to build models for partnerships would contribute significantly to the field. Although Fallik et al. (2013) proposed one model for this work that I described above, a model that is more explicitly connected to the principles of CHAT would be more useful theoretically. The recommendations that I outlined above are useful first steps for considering both how to evaluate partnerships through a Cultural Historical Activity Theory lens as well as what a future model for successful partnership building might look like.

PAPER 2

A Narrative Case Study of a Partnership Between a Local Parks System and Urban Public School: Connections to Cultural Historical Activity System

I met Jessie and Sam, nature interpreters at a park system that I will call White Oak Parks, through a professional development (PD) project I was a part of, where they worked alongside classroom teachers from an urban public school district to gain skills in using their schoolyards as extensions of their classrooms for science teaching. As we worked together, I learned more about their intentions for joining the PD - they were in the midst of a long struggle to start a partnership with a school, which I will call Morrison Academy, in the same urban school district as the teachers in the project. They felt the PD would be a useful way to get to know teachers from the district as well as learn about their lives and the context in which they work. By the time the summer PD started, Jessie and Sam thought they would have already been well underway in their partnership with Morrison Academy; little did they know it would be a much longer process than they thought.

Through our discussions in 2022 during the Spring and Summer PD sessions, and continuing conversations throughout the following 2022-2023 school year, I saw many connections between the challenges and successes of their emerging partnership and the theoretical work I had done on partnerships using Cultural Historical Activity Theory (CHAT). I became interested in documenting this partnership as a case study of this theoretical work in practice, which illustrates the process of creating the type of partnership theorized in the previous paper and shows the usefulness of CHAT as a lens through which to better understand the dynamics of such partnerships. Outlining the experiences of Jessie and Sam as they worked

through a host of challenges will show what core features of CHAT were instantiated by their work and what were missing that contributed to the stumbling blocks that they experienced.

A Brief Nod to Paper 1

Since the background information relevant to this paper is largely the same as that of the previous, I will only briefly recap the information here so as to not be redundant. As I described extensively in Paper 1, the literature on informal-formal science education partnerships has most often focused on the outcomes of informal science professional development for teachers (e.g. Goodale and Sakas, 2019; Melber & Cox-Peterson, 2005; Miele et al., 2010; Pecore et al., 2013) or the outcomes of educational opportunities for youth (e.g. Bamberger & Tal, 2008; Davidson et al., 2009; Lavie Alon & Tal, 2015) after such partnerships are already established. A stronger grounding in theory and a focus on the process of creating and sustaining partnerships will contribute to both the practitioner and research sides of the field.

Cultural Historical Activity Theory

To provide a quick reminder of the features of CHAT, I will first draw your attention back to the Engeström (2001) diagram of two interacting activity systems (Figure 1).

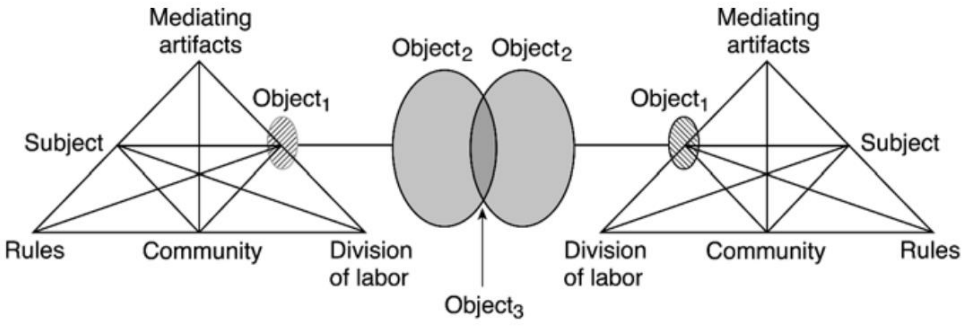

Figure 1: Two interacting activity systems in CHAT. (Engeström, 2001, p. 136)

In CHAT, two or more interacting activity systems are jointly producing new knowledge by engaging in co-configuration (Engeström, 2004) while solving a novel problem. Co-configuration involves working through and negotiating times of tension and conflict. As activity systems do this, the subjects of participating activity systems learn better to collaborate together and develop shared practices (Engeström, 2004). Another important key feature of CHAT is the consideration of culture and history as the name suggests. CHAT considers how history and culture may have shaped each activity system and this again makes context a central feature of CHAT. This provides a lens through which we might understand how and why each activity system as well as the actors within each system interact in the ways that they do.

In the first paper, I suggested a framework for creating partnerships based on five core features of CHAT, 1) outlining clear goals, 2) understanding each system, 3) articulating roles, 4) understanding and acknowledging histories, and 5) communicating and knotworking consistently through tension. This paper will be an empirical look at the utility of this framework in understanding the dynamic aspects of how a partnership was established between two complex systems and as a potential tool for those who wish to do further partnership work.

Research Questions

1. What were the experiences of two informal educators as their organization worked to establish a partnership with an urban public school?
2. What core features of CHAT were instantiated by their work and what were missing? How did this affect their experiences?

Methods and Methodology

This study is a narrative case study (Brandell and Varkas, 2001; Creswell and Poth, 2018) of the creation of a partnership between a parks system and an urban public school from the

perspectives of two informal science educators (ISErs). Telling the detailed story using a rich description (Merriam, 2009; Stake, 1995) of the creation of this partnership from idea inception to implementation will show how the participants' worked through tensions and challenges in order to accomplish their goals and create a successful partnership. Most studies on such partnerships as I noted in section one are program evaluations after the partnership already was established and detailed narratives about the creation of partnerships are missing from the literature. Below I will discuss the story of the partnership as analyzed chronologically and then connect pieces of the story to the Cultural Historical Activity Theory framework I proposed in section one.

Participants

Jessie and Sam both worked as outreach interpreters for White Oaks Parks as part of a new initiative the park system was working on in order to better reach students at local urban schools. Jessie worked in a supervisory role in this outreach initiative and had worked for White Oaks Parks for over 15 years. After the outreach initiative was established she was hired for this new position in February 2022. Sam was newly hired by White Oaks Parks shortly after in March 2022 for the role of outreach interpreter. She was hired to be an on-the-ground educator, going into the schools and engaging classroom students with nature-based interpretive programming. Prior to working for White Oaks Parks, Sam worked at an afterschool program in the same city that Morrison Academy is in, and she developed a passion for urban education and outreach. She expressed that this position was a dream job since it combined her love of nature interpretation with her passion for urban education. Both Jessie and Sam are White women with educational backgrounds in science.

I met Jessie and Sam as participants in a professional development in a larger project that I will describe below. This PD started in the April 2022, after the process of developing the partnership between White Oaks and Morrison Academy was already underway and they believed they would begin programming imminently. However, as you will learn when I tell their story below, the actual partnership did not get off the ground until the following Fall. Through our conversations during this time, I realized that their story echoed some of the theoretical work I had done on Cultural Historical Activity Theory in a meaningful way. I approached Jessie and Sam to ask if they would be interested in participating in this as a separate project and they agreed.

Context

White Oaks Parks

White Oaks Parks is a system of public parks funded by tax dollars from several urban and suburban counties, including the county that includes a large city that Morrison Academy is in. The parks system provides both recreational and educational opportunities, including a large interpretive division that provides natural history education and that includes a community outreach division, specifically designed to go to communities. This is the division that both Jessie and Sam work for. As Jessie described the organizational structure to me, the head of the interpretation division is the Chief of Interpretation and, in combination with the Chief of Diversity, Equity, and Inclusion (DEI), a new initiative was created within the community outreach interpretive division in order to specifically reach students and community members of the large city, which historically has low visitation rates at the parks. Morrison Academy was chosen as the first school with which to create a partnership because of prior relationships with administration there.

Morrison Academy and School District

Morrison Academy is a PreK-8 school located in a large urban school district. The school has over 850 students enrolled. The vice principal had taken students on field trips to White Oaks Parks when she was a teacher and that relationships was one of the reasons why Morrison was chosen as a partner school. According to Jessie and Sam, the administration of Morrison Academy had expressed that their students had low science test scores and that was another reason why the school felt that supplemental science lessons could be helpful. Morrison Academy is in a large urban school district that has over 100 schools (PreK-12). Student race and ethnicity are described on the district website as follows: 82% African American/Black, 13.6% Hispanic/Latino, 2.4% White, 1.7% Asian/Pacific, 0.3% Multiracial, and 0.1% American Indian/Alaska Native.

Teaching Science Outdoors - Urban Partnerships Professional Development

This paper is situated within a larger mixed methods study, Teaching Science Outdoors - Urban Partnerships (NSF DRK-12 #1907506). This project brings together classroom teachers from two urban school districts and informal science educators that work with students in those districts in a professional development (PD) experience. The PD has three stages - four virtual sessions in the Spring, a week of face-to-face PD in the summer at an informal site and in teachers' schoolyards, and continuing support during the following school year. Jessie and Sam, the participants in this study, were the two informal science educators that joined for one districts' PD experience. The data for this paper, therefore, include discussions, observations, and artifacts from within the PD experience as well as additional communication, including interviews and informal conversations, outside of the PD.

As noted above, the PD experience included three stages. In the Spring, we conducted four 90-minute PD sessions. These PD sessions focused on building a community, beginning to be comfortable with outdoor observations, discussions of curriculum and Next Generation Science Standard (NGSS) connections, seeing assets for science learning in urban schoolyards, and setting goals for face-to-face summer PD work. For many of these discussions, a primary focus was on helping classroom teachers think about how they might use their schoolyard for science and the informal educators served as experts in outdoor pedagogy, joining small group discussions and helping provide advice and helpful anecdotes for teachers who might have fears or concerns about taking their students outside.

The summer PD was a one-week face-to-face experience, where we met with the teachers and ISErs from 9AM to 5PM Monday through Friday. Monday through Wednesday we met at a nature park where teachers might take their students on field trips. On these days we did outdoor science observations and investigations, had small group discussions, brainstormed different tips and tricks for taking students outside, and thought about how all of this learning might translate to the schoolyard or to field trip experiences with students. On Thursday and Friday we visited the teachers' schoolyards, where teachers and ISErs helped each other see the assets their outdoor spaces had for science learning and brainstormed plans for taking their students outside.

Although this paper tells the story of Jessie and Sam and their experiences working on a partnership outside of this PD experience, the initial conversations that I had with them were within the context of this PD. As will be clear from these conversations, both Jessie and Sam felt that by engaging with teachers so closely and learning about the challenges and opportunities for outdoor learning at their schools, they were able to better understand other teachers they were

working with in their partnership as well as the school system within which they needed to do this work.

Data Generation and Analysis

The data for this paper come from conversations with and observations of Jessie and Sam throughout the PD they participated in as well as additional virtual conversations that took place collectively and individually. Each of the four Spring virtual PD sessions were recorded and additional field notes were taken. Field notes were also taken during the summer face-to-face PD. I had three virtual conversations with both Jessie and Sam during the subsequent Fall and two virtual conversations with just Sam since she was the educator in the classroom with students at Morrison Academy once their programming was established. In addition, Jessie came to three follow-up meetings with teachers that we had as part of the larger project where she shared updates;these meetings were also recorded. Finally, some of the data comes from email correspondence with Jessie and Sam across the year. Although all of the data for this project comes from Jessie and Sam and my observations of the two, they backed up their claims about the perspectives coming from Morrison Academy, such as their administrators' goals, through notes they took during meetings with those individuals.

I compiled the data using a qualitative analysis software called MAXQDA2022 (VERBI Software, 2021) and an approach from narrative inquiry (Ollerenshaw and Creswell, 2002), rewriting the story as a chronology of events. In addition to chronological coding, I also did a second round of coding to identify themes within their stories, including successes and challenges they faced and goals they and their partners expressed. Finally, I did a third round of coding using CHAT as a framework in order to identify some of the different steps I outlined in

Section One and created a CHAT diagram to represent the interaction between the two activity systems in partnership that I will present later.

Findings

As Jessie and Sam told me the story of White Oaks' partnership with Morrison Academy, I noticed patterns of successes and challenges that came up, specifically in regards to communication between partners. Here I will tell the narrative of Jessie and Sam's work and after will discuss how their work represented some of the features of CHAT and which features might have been missing.

An Emerging Partnership

The idea for creating the outreach partnership program with Morrison Academy originally came from White Oaks Parks leadership. The school district that this school is a part of is within the area that White Oaks Parks serves and, as it is a public parks system, city tax dollars go to supporting the parks. However, historically the parks have seen low visitation rates from this city. Jessie explained that their major motivation was to "further offer our services to areas where we hadn't." The parks system had not focused outreach programs specifically on this city and they realized that they should be in order to address one of their mission statements that the parks were "for all." One of the ways that park leadership decided they could address this identified problem was to bring interpretive programming to the schools through the creation of a new community outreach division and the creation of a partnership. As Jessie explained, "our new division of the [parks] is really intended to go into [city] and really reach the students who haven't had the opportunity, and communities, to come out and make use of the parks."

They reached out first to the administration at Morrison Academy because the Vice Principal had previously taken students on field trips to White Oaks Parks. This prior

relationship was important in Jessie and Sam's mind because they felt the Vice Principal already had experiences that led her to understanding the benefits of outdoor education experiences. This administrative buy-in allowed for an easier transition into the classroom later. Jessie explained that their goal was to start at Morrison Academy, but they also "hope to be able to radiate out further into other schools."

The next step after identifying a partner school was outlining each partners' goals for this collaboration. These goals were shared with me by Jessie and Sam, but also reinforced by the White Oaks Park's website. The goals of Morrison Academy came from Jessie and Sam's notes from meetings with school administration. In addition to the primary goal of reaching the students and community of the local city, White Oaks Parks leadership had additional goals as well that included increasing students' science knowledge, increasing awareness of the parks system, increasing kids' and teachers' connection to local natural spaces, and increasing the knowledge of and interest in STEM careers and careers in parks. The administration at Morrison Academy also had their own goals. Jessie said,

> Before I was here, my supervisor had had a conversation with this teacher from the school that we were working with, not the vice principal from the school that we had worked with in the past and said, you know, we're starting this program, we're curious, what do you need? What could we offer to support you in your science education programs, because we have these interpreters who want to - who we want to send out to your schools. And so that's how these supplemental science lessons, kind of the idea for them got started.

The specific goals that Morrison Academy wanted to address with supplemental science lessons were to increase their historically low test scores in science, to increase teachers'

capacity for teaching science, and to help teachers in planning outdoor science lessons. Specifically, one of the requests from the school administration was "helping teachers with their planning, so that they feel more empowered, or capable of taking their students to do investigative science outdoors." Notably, these goals in the beginning planning phase were all discussed solely with administration in the school, not the teachers themselves.

Encountering Red Tape

These initial conversations that led to the idea of providing supplemental science lessons happened before Jessie and Sam were hired on in their positions. When they were hired, they were under the impression that the official paperwork on the district level, specifically a Memorandum of Understanding (MOU), had already been submitted and they were just waiting for approval. Jessie explained to me,

> When I came in, in February [2022], I figured well, anytime we'll be able to get started by April, maybe even by the end of March, you know, things are gonna go fast. They do not go fast. There is nothing, nothing at all fast about it. The vice principal did not understand their procedure. We did not understand the procedure… And then finally, I realized, I think it must have been, was it March 4, probably, that we did not have an MOU signed up at all, like we had nothing.

They still did not have their MOU approved during our summer professional development together despite their goal of starting programming during the spring of the 2021/2022 school year. Not only did they not understand the procedure at first, but during our time together summer 2022, Sam and Jessie explained that they had also encountered a lot of administrative turnover, realizing they had been talking to the wrong people, not getting responses to emails, and more. Sam explained,

> Another thing that we ended up finding out recently through a meeting with somebody from [county education office], he had worked with [school district] longer than we have, and he was kind of giving us some insight. So on top of everything that [Jessie] had just mentioned, then we find out that there was turnover in their administration office. And the people who were turning over were the people that we needed their support, you know, so and we needed them as well to be able to push this MOU forward. So that has been the other challenge as well.

School System Structure

One of the challenges that Jessie and Sam faced at this point was their own lack of knowledge about the structure of the school system they were working with. Sam expressed that they realized there were "almost different tiers" and that "understanding their organizational structure" was crucial to figuring out who to talk to and where to go next when certain people were out of the office or not responding to emails. The school district had a very different structure than the parks system. Although White Oaks Parks still had a hierarchical structure and Jessie and Sam had leadership that they needed to report to, the school district was an entirely different beast. They had to talk to administrators at the county and district levels, the partnerships office, the district science consultant for Morrison Academy, the principal and vice principal of Morrison Academy, the cohort leader of science teachers, and someone who was overseeing school improvement.

In August of 2022, they finally had a stakeholder meeting with all these different people, which allowed them to get a better understanding of everyones' expectations and goals. They felt as though this meeting was one of their first big wins as they were getting buy-in from the most important people to break through the red tape they had experienced. However, they had still not

talked very much with the actual teachers whose classrooms they would be going into to do the supplemental science lessons. Jessie and Sabrina weren't too worried about that though. Jessie expressed to me,

> I really felt like that was the most important people to get to first because if we didn't have the buy-in from the principal and the vice principal, we weren't going to really get anywhere on this MOU level. We've worked… you know, we're good at talking to teachers and customizing programs for teachers. And we do that at [White Oaks Parks] all the time… Maybe I'm underestimating how hard it's going to be or something at [Morrison Academy]. But I feel like we have a lot of experience with that part. For me, the part that I really stressed out about was making sure we have that connection and the buy-in from the gatekeepers of the whole school.

Finally Getting Past the Red Tape

I chatted again with Jill and Sabrina in late September 2022 and learned that just one day prior they finally received the fully executed MOU. Jessie told me, "...in my heart, like I felt like I was gonna cry yesterday, when I finally got this email from their partnership office… That process was full of barriers." Sam echoed this by saying "I watched Jessie work very, very hard to get that MOU and to get with the right people and to all the meetings and all the emails that she sent." I also learned during this discussion that while they were waiting for the MOU to be approved, they had pivoted their plans a bit and started a couple of after-school programs with other district schools, one for middle school and one for high school students. Sam was primarily in charge of leading the creation of these programs and both she and Jessie felt like being able to have an impact while they were waiting for official permissions to be in the classroom was really motivating. Jessie explained,

> [Sam] was really successful in building those relationships with the teachers to make the club move forward. And while I was like, just muddling around in the [district] stuff, and dealing with, you know, in the weeds, trying to figure out the MOU, she was able to kind of run with that. And so we felt like we were still moving forward.

First Conversations With Teachers: Feeling like Outsiders

Although Jessie and Sam expressed previously that they were not worried about the lack of contact they had been able to have with teachers up until this point, there was an interesting difference between how they discussed the after school programs that they had created alongside teachers and their classroom programming that they had planned with only input from administration. In late September, they were about to enter the classrooms but had not had many conversations with the teachers whose classrooms they were planning to go into. Sam said,

> We're currently in the process of trying to set up meetings to see where the teachers are at, because [Jessie] and I have met with a lot of different people over a long course of time. And we've, we've kind of been told some things that are the same, and then some things that are different. So right now we're really focused on talking with the teachers and seeing where they're at. And getting an idea of, okay, what is it that we can bring, that will be an extension of what you're doing in the classroom, that's not replacing them, and not replacing their lessons that they have to get done with their pacing.

Jessie and Sam said a few things to me that indicated they felt a bit like outsiders in the school and they were worried about stepping on teachers toes or having teachers feel like they were forcing things on them. In contrast, as you saw above, Sam was very successful in the after school programs because of the relationships with teachers that she built. One success that made them feel a bit less like outsiders was being invited to join their science curriculum meeting, also

in late September that was led by the school science coach. Jessie expressed this when she said, "we were able to kind of be in the room with the teachers and that felt pretty good. I don't know if it felt good to them. But it felt really good to me to be able to have a sense of like, like to just get a sense to be around everybody. I felt very thankful that we were included in that meeting."

However, at that meeting they also got a sense that the planning they had done in advance with only input from administration was potentially not going to be as useful as they had hoped. Sam explained,

> [Jessie] and I were trying to prep for the school year knowing that our schedule was going to be really crazy… And then we went into this curriculum meeting on Wednesday, and then you start to hear what the teachers are saying and you realize, oh, wait a minute… things got moved around in the curriculum. We went in with last year's curriculum guides trying to prep for the school year… now we get to go in and talk to the teachers and see, you know, where *they* anticipate being and then with that information, then we can kind of start creating lessons or programs that fit in nicely with what they're doing. Because, you know, we all kind of have an idea of the timeline, and then reality hits. And that timeline is not what we thought it was going to be.

Not only were the curriculum guides they had originally been using not correct, but they also realized that even with the revised curriculum guides, teachers were often not on the timeline of the guides at all anyway. They expressed that they realized that planning for the year or semester in advance wasn't really realistic with how the teachers planned. They would have to come up with a lot more lessons "on the fly" as Sam described it to me, depending on where teachers were in the curriculum on any given week.

Engaging with teachers during the Teaching Science Outdoors - Urban Partnerships PD also helped Jessie and Sam come to understand more about the teacher context than they had understood previously. Even though the teachers who were part of the PD were from different schools, they were all teachers in the same urban school district. Jessie and Sam expressed that hearing some of their stories about their relationships with administrators was eye opening for them. For example, Jessie said,

> I learned a lot from the teachers too… just like what they're going through, and the relationship they have with their admin, like just observing those interactions. That was huge to me… we have been interacting with admin, some of those experiences kind of popped into my head every now and then, like, it's not just me, this is just a thing. This is part of like the culture of how it is, you know, in the school district in some ways, so it helps me just get a really better perspective of the district and our role there.

During the PD we heard stories of teachers having tense interactions with their administrators and even witnessed one instance of a teacher being scolded in front of all of us by her principal. Several of these stories revolved around getting permission to take students into their schoolyards whether for learning or just for recess, which several schools did not have despite it being a district requirement. Although Jessie and Sam knew that they had permission to take students outside at Morrison Academy, I think these stories helped them recognize some of the power dynamics that can be at play between teachers and administration.

Starting Classroom Programming

On October 10, 2022 the White Oaks Parks team was finally able to start programming in the classroom at Morrison Academy. One thing that was helpful for them was that Morrison Academy had focus teachers for science for each grade, who met with each class every day. So

as the White Oaks educator helping out twice a week in 4th and 5th grade, Sam only had two teachers she needed to plan with and that made building relationships quickly a bit easier. I talked to Sam a few weeks into their programming to catch up and learn how it had been going. Overall she felt positively about the activities she had been able to do so far. She expressed that she felt they got really lucky because the teachers were welcoming of her entering their classroom and that there was no tension so far. However, she had already encountered a few unexpected challenges.

One challenge that she had experienced was in trying to accomplish their goal of supplementing curriculum. Again that curriculum pacing guide, even the revised one they had gotten, wasn't particularly useful because teachers didn't necessarily follow it. She said,

> So the one request that both of my teachers had was to not get ahead of them in [the curriculum]. So because a lot of them look at the lesson for the day the night before - whatever they're teaching on Tuesday, they're not looking at it until Monday night. So um, so some of the lessons that we did with the students are kind of off of curriculum… some days I have to do what they're doing on the curriculum, and then other days, I have to have something on the side ready to go because he might not be there yet.

A second challenge that Sam experienced was a lack of time to have planning and check-in discussions with teachers. I asked her how check-in meetings with teachers were going and she explained,

> The check in meetings, they go pretty quick. And the reason for that is because I'm talking to them during their prep hour… I have to find that balance of like, okay, we need to have a discussion about you know, what worked today and what didn't, where they're going to be in the curriculum, and then just future plans, and then also not eating up their

> entire prep hour. And so the meetings probably only last 10 minutes at the most… I ask, is there anything else that you're hoping for me to do with the students? And his answer is always like, just expose them to something different, just expose them to something different. And so when it comes to like, what they're expecting out of this, it's not very clear. And so it kind of makes it a little bit more difficult for me to have a real good target for my lesson.

One concern that Sam had prior to entering the classroom was that since she was there twice a week doing her programming, she could disrupt the curriculum pacing that the teachers had planned on. She expressed that she had asked about this multiple times, again afraid that she could be stepping on teachers' toes. Although this connection was not made explicitly in our discussions, it seemed to me that one of the reasons for this was because the idea for programming and what they were initially told were the goals for their work were all from district and school administration, not teachers. Luckily, Sam said that so far she had been told that she was not disrupting the pacing of their curriculum. She told me that based on her observations in the classroom and from discussion with teachers that, although they have each class every day for an hour of science, "teachers may not entirely teach the whole hour of science… they'll do a little bit, and then they give them the rest of the hour to have free time."

Although both teachers had been welcoming and positive about her work so far, the lack of relationship built also caused a couple challenges. The fourth-grade teacher she was working with had some lower back problems and Sam found out at the same time his students that he would be getting surgery in December and then be out the rest of the school year. Sam realized she didn't know what this meant for her programming for January to June and also didn't really have the relationship built with the teacher to feel comfortable asking further questions. In

addition, this echoed some other frustrations she was having about being unable to plan much in advance. She expressed to me,

> That's also the part of the communication that is a little frustrating is that it's like, you can't get too far down into this. You can't get too ahead of the schedule. So like, you know, if we're going to be talking about something in December, we really can't start talking about it until like the end of November. You know what I mean? Like, it's really like, at a, like a week by week basis.

Communication Improvement

Throughout the Fall semester I continued to check in with Sam about the different activities she was leading and how things were going. I could tell with each email and conversation that she was getting more comfortable being in the classroom and getting to know students and the teachers better. She explained to me over email that the two teachers were very different and so she had to figure out roles she and the teacher would take for each class separately. The fourth grade teacher, Mr. W, was a lot more confident, and Sam said he took a much more active role in the activities while she was there. The fifth grade teacher, Mr. S, was a second-year teacher and this was his first year teaching science. He preferred to take more of an observer role while Sam was leading instruction, but would help with classroom engagement and keeping students on track. Mr. W was also the teacher who was having back pain, which meant he was unable to go outside with Sam and the students. So Sam had to plan more activities where she brought things from outside into the classroom. Sam wrote to me,

> We tried taking the students outside without him and it didn’t work out so well. Even after setting outdoor classroom norms and rules. He and I both agreed that it’s best to do

the activities inside for now until he's fully mobile again. With that said, I've done my best to bring the outdoors inside the classroom. It's just extra prep work on my end.

By the beginning of the spring semester, Sam expressed that communication had improved a lot. She wrote to me that she had a much better understanding from both the teachers as well as the Vice Principal what kinds of lessons would be the most beneficial to accomplish all of the goals they had set. Sam had also started communicating with teachers outside of those quick check-in meetings during their prep-hour. In fact, even though Mr. W was out for a few weeks for his surgery (he did not end up needing to be out all semester), they continued to communicate on the phone while a long term substitute was in the classroom. She felt more of a part of the classroom instead of someone coming into an already established community. Sam even said,

> [Mr. W] and I are starting to communicate more outside of school time. It's not a lot, but he and I share a common interest in football, so we've sent a couple of texts back and forth about the [University] games. He likes to taunt me when they lose lol. Also, when he was out for his surgery, I promised him that I would send pictures and videos of the students doing the activities to him. I sent him something every Friday he was gone.

Jessie attended some of our Teaching Science Outdoors - Urban Partnerships follow-up meetings along with teachers throughout the school year and also provided some updates programmatically and from her perspective as a supervisor. For example, Jessie said,

> [Sam] wrote a report for our [White Oak Parks] board meeting, I should mention, that talks about her activities that she's been doing in our outreach department… and one section was called, gosh, I'm trying to think of what she called it, The Hug-A-Thon. So she has definitely bonded with the students in each of the classes, she said like at the end

> of the day, it's just all the kids coming up to see her and wanting to hug her, you know… so she's developing that foundation and those relationships and everything and it's so cool to see.

She also shared that both teachers and administration at Morrison Academy had expressed interest in continuing the partnership the following year and she attributed a lot of that to the better relationships that they had developed. Not only that, but White Oaks Parks leadership was also happy with how the partnership had developed. They had hired one more educator to work in Morrison Academy with additional grades and were still hoping to expand as well to other schools in the district in the future. Jessie said,

> Finally, I think it's just finally building those relationships, building those foundations and getting used to being in the school and the school was getting used to seeing us. And it's just a lot slower process than my very optimistic nature realized going into this whole project… those relationships take time, but it's so rewarding to hear the fruits of that labor. I'm still hoping we can just continue rolling with this and next year the MOU process is a better, easier thing to do, the second time around.

Discussion

From my discussions with Sam and Jessie as well as our email communications and interactions during the professional development project, I recognized features of CHAT that were instantiated by their work as well as some that were missing and that I felt contributed to some of the stumbling blocks that they experienced. I created a CHAT diagram based on White Oaks Parks and Morrison Academy as two interacting activity systems (Figure 2). Below I will describe the two systems through the lens of CHAT and then go back to the five CHAT-based recommendations from Paper 1 and discuss how each recommendation is represented by this

case of White Oaks Parks and Morrison Academy. The five recommendations are 1) outlining clear goals, 2) understanding each system, 3) articulating roles, 4) understanding and acknowledging histories, and 5) communicating and knotworking consistently through tension.

White Oaks Parks and Morrison Academy as Interacting Activity Systems

If we use a CHAT lens, we can consider the partnership between White Oaks Parks and Morrison Academy as two interacting activity systems; as such, we must consider all the parts of each system. Looking at Figure 2 below, first I draw your attention to the subject of each partnership - Jessie and Sam, who represent White Oaks Parks and the administration (Vice Principal) and focal teachers (Mr. W and Mr. S) from Morrison Academy. However, beyond the subjects who are primarily interacting in this partnership, there is a larger community and division of labor in each system that influences that (and all) activity. This was one of the first things that it was vital for Jessie and Sam to learn about the Morrison Academy system; not only did the work of the administrators and teachers influence the system, but the various players within the district and their hierarchical structure were important to get to know as well in order to break through some of the barriers they faced when trying to start their partnership (Figure 2, "Community and Division of Labor").

Figure 2 also shows each systems' objects, or goals, as well as the overlapping objects between the two systems. It is important to note that some of the objects from both systems come from different individuals within the system; at Morrison Academy, the administration and teachers had different goals. As I will discuss in more detail below, none of these goals were in opposition to each other, so the subjects of each system were able to prioritize overlapping goals, but without eliminating any of the other goals.

The mediating tools and artifacts included in Figure 2 are examples of some of the many different tools used within each system. These examples came up in conversations with Sam in particular as she worked to figure out how she might use the science curriculum and classroom technology tools to her advantage as well as sharing the outdoor investigation tools with teachers for their future use.

Finally, it is important to consider the rules and norms of each system that are also shown in Figure 2. These again are just examples of some of the different norms that came up in conversation with the study participants. For instance, Sam noted one of the things she had teachers help her with first was learning some of the attention grabbers and rules that they used in their classes so that she could adhere to the same classroom norms as much as possible. However, she also brought in some of the norms from informal science education, such as more free-choice, less structured activities, particularly during outdoor activities that she led.

Looking at the partnering organizations as two interacting activity systems, individuals within White Oaks Parks and Morrison Academy engaged in work that can be analyzed using the recommendations proposed in Paper 1. Below I will discuss how the work of people within these two systems adhered to these recommendations and where they did not and how that affected their partnership.

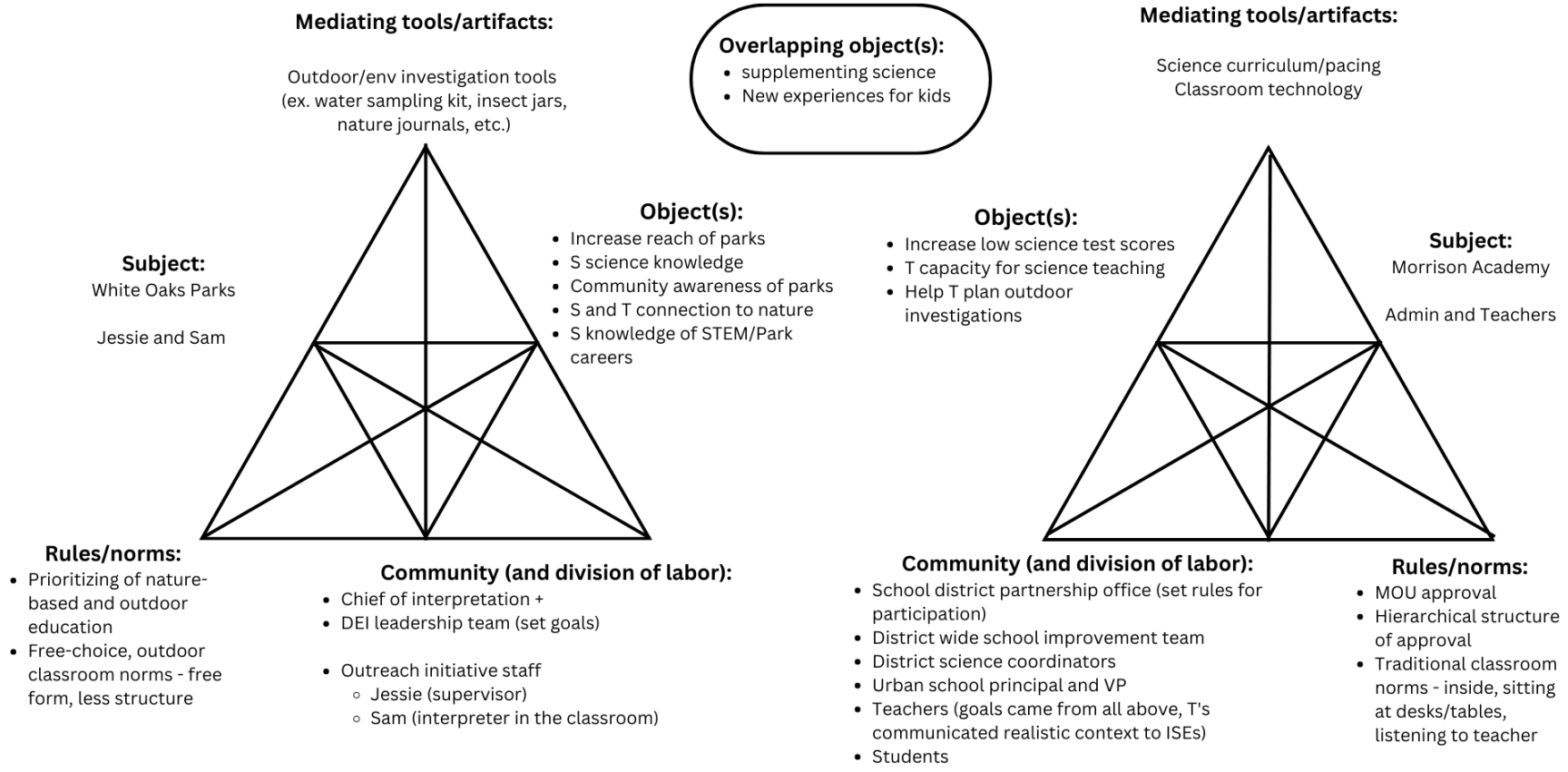

Figure 2: The interacting activity systems of White Oaks Parks and Morrison Academy

Outlining Clear Goals

The first conversations that White Oaks Parks' leadership and Morrison Academy administration had were around goal setting, which is an extremely important primary step when developing a partnership. The two systems had different goals, with White Oaks Parks' goals including outreach to communities that they had historically low participation from, to increase student science knowledge, to increase student and teacher connection to nature, and to build awareness of the parks as well as career opportunities in the parks. Morrison Academy administration was primarily focused on increasing student test scores and increasing teacher capacity for teaching science, especially in the outdoors. One overlapping goal was increasing student science knowledge, with the parks focusing on knowledge of natural history and the school focusing on test scores. As a way to accomplish these goals, together the idea of White Oaks Parks interpreters planning alongside science teachers to provide supplemental lessons to enhance curriculum was suggested.

Although this could be seen as a good example of outlining goals, Morrison Academy teachers who were important key players in this partnership were not part of these conversations. This caused some challenges later as Jessie and Sam were planning and enacting the programming they had planned based on goal setting between them and the school administration. Since administration was not necessarily aware of the needs and context of the classrooms themselves, this was not part of the planning.

Once programming started in the classroom, Sam felt worried that she was coming in and stepping on teachers' toes because she didn't know their expectations or hopes for the partnership. She explained that when she had conversations with teachers about their goals for her lessons, she didn't get very clear answers or would only get answers like, "provide

something new for the kids." Unlike the administrators who because of their positions prioritized test scores and teacher capacity for science, the teachers expressed that they wanted their students to have engaging and novel experiences. According to Sam, teachers did not seem to prioritize communicating with Sam about curriculum connections, or any parts of the curriculum that students were struggling with and could use supplemental activities to create better connections. This led to less of a focus on the original idea of supplemental lessons that connected to curriculum and more of a focus on fun, new interpretive experiences. However, once Sam started building better relationships with teachers and communicated more effectively, they were able to better tailor lessons to accomplish goals of supplementing curriculum and providing new, fun experiences. Had teachers been involved in initial goal setting conversations, these initial challenges may have been avoided.

Understanding Each System

As I described while telling Jessie and Sam's story above, one of their biggest challenges was getting started because they were not knowledgeable about the school system, the permissions they needed, and who they needed to talk to in order to get past all the red tape they encountered. Not only were they unaware of the intricacies of the district hierarchy, even the Vice Principal at Morrison Academy who was their primary point of contact initially was not aware of the system in place to get the memorandum of understanding. Jessie and Sam told me multiple stories of times when they felt they had finally figured out the right person or office to talk to only to find out there was turnover or someone was out of the office long term without a replacement. A process that they thought would take a few weeks took close to eight months instead. Having such a complex system and no centralized way to gather information about and understand who to talk to made developing any kind of partnership very difficult.

One way that Jessie and Sam came to understand more about the urban school system more broadly and particularly the teacher context and experience was through their participation in the PD. This not only helped them learn about the urban classroom context and the specific challenges that teachers face, but it also helped them understand that they were not alone in having frustrating experiences trying to communicate with central district administrators.

Articulating Roles

The third recommendation for partnerships based on CHAT is for each subject of the systems to clearly articulate their roles and responsibilities. Similarly to the outlining of goals in this partnership case, the articulation of roles did not include the teachers at the beginning of the project which led to a bit of confusion when Sam started programming in the classroom. The park interpreters' roles (leading supplemental lessons twice per week) and the teachers' roles (learning outdoor pedagogy through observation) in the classroom were decided between the park staff and school administration without input from teachers. Sam and Jessie both explained that they got very lucky with the teachers they were working with because they welcomed them in the classroom and seemed happy with these roles. However, I could easily imagine a different outcome because of their lack of involvement in these decisions.

In addition to these overarching roles, smaller day-to-day roles also needed to be negotiated between Sam and Mr. W and Mr. S. The roles each teacher took during Sam's lessons differed between the teachers, with Mr. W taking a more active participatory role and Mr. S taking on more of an observer role. Sam and both teachers were able to figure out this balance and what worked best for them fairly quickly into programming which allowed Sam to have a better idea of what to plan for each lesson.

Although the articulation of roles worked out for this partnership despite not all participants being involved, my recommendation would be to involve everyone in this discussion. Especially in partnerships where there may be power dynamics involved in a system or between systems, roles should not be decided for one participant or partner, but negotiated between them in order to best figure out how to accomplish the goals already set.

Understanding and Acknowledging Histories

The fourth recommendation of understanding and acknowledging histories is the least concrete and therefore often the most challenging step. Many individuals do not know the historical contexts of their own institutions and therefore sharing this information across systems can be difficult. This may not seem directly related to the partnership in the same way as sharing goals or the roles each partner may take, however coming to see where these priorities come from can lead to greater understanding in collaborative work. In the case of Jessie and Sam, the place where this work was done the most was during the PD alongside teachers both during planned discussions around the culture of schooling in the district and during casual conversations with teachers. One example of a conversation like this was when we talked about barriers to working with students in the teachers' schoolyards. Teachers discussed both administrative barriers, like their principals not allowing outdoor time, but also safety and emotional barriers. For example, the teachers discussed that many students lived in neighborhoods that were unsafe to be outside in and that led to them feeling unsafe and uncomfortable outside in the schoolyard. The majority of students and teachers in this district identify as African American/Black and we know that the outdoors is not always a safe space because of both historic and recent acts of violence in the outdoors against Black and Brown people.

This was not only unfamiliar to Jessie and Sam themselves, who both are White, have positive associations with being in the outdoors, and who live in areas where it is safe to be outside, but most of the visitors to White Oaks Parks also are individuals who are comfortable in outdoor spaces. Coming to better understand how the differing perspectives of teachers and students in the district and themselves as interpreters are influenced by different life experiences influenced by history was important when thinking about how they would frame their work at Morrison Academy and would allow them to better understand different perspectives that they might come across.

Individual teachers and informal educators will also have their own personal histories that influence their views about what is important to teach and learn. They have their own experiences as students and as educators. Therefore, sharing these perspectives with all partners would be important. In the case of Sam and Mr. W and Mr. S, they did not have many of these conversations. However, one aspect of personal history that allowed for Sam to have a bit of a better understanding of the two teachers was their varying experiences as teachers. Mr. W had been teaching for many years, while Mr. S was a novice teacher who had never taught science before and had not had positive experiences with science in his own education. This impacted some of her interactions with the two teachers; Mr. S observed her teaching more with the intention to learn about both science content and pedagogy, while Mr. W participated in activities more.

Communicating and Knotworking Consistently Through Tension

As we know from Sam's description of her communication with teachers was that it was minimal at the beginning of the project, even once she got into the classroom and began teaching lessons. She only met with teachers during their preparation hour for about ten minutes, which

did not allow them to have very meaningful conversions about how each partner felt about how things were going. Sam would get very short, mostly positive, answers from teachers and a quick description of where they thought they would be in the curriculum next time she came in. Sam felt like asking for more time to discuss how things were going was stepping on teachers' toes because that prep hour was extremely important for them and she wanted to respect their time. However, this meant she was unsure about teachers' true expectations and feelings about the partnership. She also didn't know who to reach out to with questions. For example, when she found out Mr. W was getting surgery, she had no idea who was going to be taking his place in the classroom. She did not feel comfortable asking Mr. W and also didn't like bothering the vice principal because she was always busy.

As those relationships became more comfortable, Sam was able to communicate better with teachers. Their communication got more efficient, they were more comfortable giving constructive feedback to each other, and Sam also was able to communicate with them outside of that small prep hour window. This allowed them to much more easily work through challenges together as partners instead of separately. Sam also got feedback from the vice principal who sat in on some lessons which gave her more confidence that the lessons she was doing were matching their expectations.

Building relationships that allow for better communication does take time, which is why it is important to focus on relationship building as early as possible in a partnership so that communication can be effective whenever challenges and tensions arise. This is another reason why having the teachers involved from the outset of the partnership would have been beneficial for White Oaks Parks and Morrison Academy.

Conclusion

White Oaks Parks interpreters and Morrison Academy teachers were able to engage in a successful partnership once some of the initial challenges were solved. CHAT is a useful framework with which to think about the successes and challenges they faced and why. Since the subjects of the two systems were engaging in work to create something new, there was no expert to consult with about the best way to create this partnership. Sam and Jessie had to engage in knotworking (Engeström, 2001) with various players in the public school system, which they had very little knowledge of at the start. Had there been a tool built for practitioners they could have used to understand some of the important steps to take when initiating partnerships, they might have been able to have more success from the beginning and avoid some of the setbacks they encountered. As such, this theoretical framework could be a great asset to the field and can inform how we might create, analyze, support and sustain productive partnerships to benefit the entire science learning ecosystem.

PAPER 3

How to Move Beyond Access: Informal Science Educators' Perspectives on DEI

Systemic exclusion of historically marginalized people (i.e. BIPOC individuals, women, LGBTQ+ individuals, and disabled individuals) in science spaces is an issue across the science learning ecosystem (Bevan, 2018). Many scholars have focused on the exclusion of historically marginalized students in the formal science classroom (e.g. Mutegi, 2011) and more recently in informal science education (ISE) spaces like zoos, museums, nature centers, etc. (e.g. Dawson, 2014; Tal, 2020).

The reasons for exclusion and discrimination in ISE spaces, and particularly in outdoor learning spaces, are many, including accessibility issues such as transportation and cost of entry. Much more than this, however, is the fact that these spaces uphold a dominant narrative of Whiteness (Gosalvez, 2020). Leadership roles in these spaces are primarily held by White individuals (Gosalvez, 2020) and most informal and/or outdoor educators working directly with youth are also White (Rende et al., 2021). A consequence of this culture and structure is that individuals of Color often feel like they don't belong or are unwelcome in such spaces (Feinstein and Meshoulam, 2014). The outdoors is not always a safe space, particularly in the wake of recent acts of violence against Black and Brown individuals in the United States. One such event involved a White woman calling the police on a Black birdwatcher in Central Park in New York in 2020. Black and Brown youth attending informal and outdoor education programs may therefore feel unsafe in and unsure about the space they are in.

These issues are present beyond the border of the United States as well. In Israel, for example, researchers found "...underserved communities and minorities do not have the same access to ISE institutions and that these communities and minorities feel excluded, even when

they visit such institutions" (Tal, 2020, p. 428). A study in the UK found that children from historically marginalized groups lacked access to the outdoors, particularly in times outside of school. Additionally, when they did have access to outdoor educational opportunities, they often felt like they were not represented and did not have a voice in the experience (Waite et al., 2021). In another study, Dawson (2014a) found that people from low income and minority ethnic groups in the UK felt that ISE experiences were not designed for them. Thus, issues of exclusion and representation are ones which outdoor educators across the world need to address.

Notes on identity and DEI

The construct of identity has been examined in different ways across fields and through different theoretical lenses. Additionally, there are many salient aspects of identity that may affect a person's engagement with science in intersectional ways, like gender, race, and/or ability as overlapped and intertwined, creating a unique experience. In this paper, I focus in particular on race as one salient aspect of one's identity. By doing this I may simplify some aspects of intersectionality. However, race is of particular importance in this context because the large majority of informal educators are White, and as the field works to broaden participation for historically marginalized groups including BIPOC youth, I assert that educators need to consider how their own racial identities and those of their participants affect their beliefs and their work. Most importantly, in order to disrupt patterns of racial exclusion in science spaces, educators across the science learning ecosystem must reimagine science education as a means for social justice (Bevan, 2018).

The concepts of equity and justice have also been discussed and examined in many different ways. In this paper I frequently use the term Diversity, Equity, and Inclusion (DEI) to refer to all efforts that address increased diversity (particularly racial diversity), equity or

meeting communities and individuals where they are and providing necessary supports for success, and inclusion or providing equal access to. Notably, DEI does not include social justice as a concept and it perpetuates the idea of access being one of the most important things to address. As a research in this space, I do not believe the term DEI encompasses all of the important concepts when we discuss systemic injustice or exclusion in science education. However, it is the term that is most meaningful and universal to the educators I talked to in this study and their organizations. It is a common term used by the field to talk about race, equity, and justice and made the conversations more comfortable and accessible to my participants.

Researcher Positionality

I am a White, cisgendered woman who worked in the outdoor education field. My racial and gender identities match the majority of ISErs in all of these settings and I never experienced feelings of being an outsider to these communities. I have an immense amount of privilege that caused me to be unaware of systemic issues of race, gender, and ability that are prevalent both in the science field and the outdoors. Like many in the outdoor education field, I thought the primary issue the field needed to address was promoting equal access and took for granted that I always felt like I belonged in these spaces, so I assumed all other students would as well. I now know that equity in the outdoors must go beyond access.

Unfortunately ISErs often get minimal information, if any, about visiting students prior to them attending programming and have less time with students to get to know their interests, backgrounds, and experiences and how to make programming relevant and meaningful for them. In addition, opportunities for continued learning or professional development, specifically about pedagogy, in the positions I have been in were extremely limited. There is a lack of professional knowledge about DEI in the field beyond discussions regarding access. This is why I am

passionate about starting these conversations with ISErs and figuring out how to support them in learning about their own positionalities and those of their participants.

Perspectives on equity

One barrier to implementing meaningful change within the ISE field that scholars have noted is that "the very conception of equity in the field is a moving target, shifting widely in meaning across contexts and research perspectives" (Philip and Azevedo, 2017, p. 526). The variety of conceptions of equity and its importance also means that the types of action taken in science spaces also varies greatly. Most commonly, Western discourse positions science and science practices as apolitical, or neutral; informal science institutions are therefore seen as spaces where social and political issues are irrelevant (Bang et al., 2012) and the learning that occurs in these spaces is seen as useful and relevant to all. Equity initiatives in these spaces focus on increasing access for all to be able to engage with this "neutral" scientific knowledge and do not envision changes that reshape structures and systems that perpetuate inequity (Philip and Azevedo, 2017).

Philip and Azevedo (2017) described 3 categories of discourses that exist around equity in research on out-of-school science learning in particular. The first is "discourses that emphasize increased student achievement and identification with science" (p. 528); this is often the type of discourse we see in much of the research that focuses on out of school science learning as a way to promote science interest, science knowledge, and interest in science careers. This discourse most often aligns with the perspective of science as neutral and relevant to all and leads to efforts for increasing access for historically marginalized individuals. This discourse also is extremely common in ISE research. The second category the authors describe is "discourses that problematize the privileged forms of science" (p. 528). This category of discourse positions out-

of-school science learning as having the potential to change what we value in science and expand our understanding of what and whose science practices are seen as legitimate. The third category of discourses are "discourses that identify science in justice movements," (p. 529) which prioritizes social justice movements as the starting point and science as one tool that can be used to identify solutions.

Varying perspectives on equity exist among scholars in the field as well as among practitioners. In a study of 15 science museums and centers, Feinstein and Meshoulam (2014) found that conceptions of equity varied greatly across institutions, and despite ISE employees' awareness of a lack of diverse participants and staff, efforts by these institutions were little more than attempts to increase access. The researchers suggested that science museums and science centers viewed their relationship to community in one of two ways - what they refer to as client logic, or viewing themselves as serving the needs of a community that is separate from themselves, or cooperative logic, where they see themselves as part of a community. These two varying perspectives related to the institutions' definitions of and efforts around equity (Feinstein and Meshoulam, 2014).

Going Beyond Access

While access to informal science spaces is important, this is where conversations and efforts have often stopped. This view is not only limited but misguided, because it assumes that informal institutions are already providing relevant resources, learning opportunities and perspectives for all visitors. Research, including that presented above shows that for marginalized participants, this is not always the case. There is often a deficit narrative in informal science spaces of participants and their home communities with respect to such things as nature experiences and science knowledge, and there is an assumption that it is the informal

institutions' job to fill that gap (Feinstein and Meshoulam, 2014; Philip and Azevedo, 2017). A focus solely on access reinforces this deficit narrative.

In fact, while many museum leaders and staff devote significant time and resources trying to lower barriers to participation and make engagement appealing and enriching, those efforts most often take place without an examination of the underlying cultural biases and norms. When this is the case, the barriers are merely lowered for the same audiences museums are already serving as they haven't made the experiences more welcoming or relevant for marginalized youth and families (Feinstein & Meshoulam, 2014).

These shallow inclusion attempts promote assimilationist messages by trying to increase participation or visitation of existing science experiences without considering why experiences might feel unwelcoming or culturally irrelevant to some visitors (NRC, 2009; Dawson, 2014). One reason for this is that those that are in charge of inclusion efforts are largely unaware or ignorant of the underlying cultural biases that informal science spaces perpetuate. Bevan et al. (2021) describes this in the context of science museums when they say

> … the "problem" (participation) and the "solution" (access) are framed largely by people who themselves have embraced and thrived in a culture of science and/or a culture of museum going, and who see museums as empowering rather than potentially enigmatic and alienating places. (p. 111)

Systemic barriers to broadening participation

Research has attempted to address many barriers to broadening participation and promoting equity in ISE. Bevan et al. (2021) along with The Center for the Advancement of Informal Science Education (CAISE) published a report that discussed the findings of a task force and that described four systemic barriers to broadening participation in informal STEM

(science, technology, engineering, and math) experiences: perpetuating a narrow definition of what "counts" as STEM participation, reinforcing White, male, and western norms of science, missing connection-making between former and future experiences, and placing equity as a lower priority than science knowledge.

When equity does not receive priority at an ISE institution, equity efforts often only occur when extra funding is available (Feinstein, 2017, Bevan et al., 2021). In addition to monetary resources, scholars have also noted staff resources can be a large barrier to implementing equity efforts (Feinstein, 2017). Staff that take on equity efforts can be marginalized themselves if equity is not the priority of the organization (Bevan et al., 2021).

Potential of informal education to be spaces for social justice

Despite the systemic barriers to substantial equity efforts, there are some examples of effective social justice efforts in ISE spaces that illustrate the potential of these spaces to disrupt exclusionary science norms. Bevan (2018) suggests that conceptualizing ISE as part of a STEM learning ecosystem, which also includes community and family science engagement, allows for connections across contexts and asset-based community engagement with science. Positioning science learning in informal spaces as an ecosystem does not put school science learning above family and community learning, but instead considers all contexts in which people engage with STEM and the histories and cultures within all these spaces.

One context in which quite a bit of work has been done has been in makerspaces and has focused on socially just and community engaged making (e.g. Calabrese Barton, 2020; Calabrese Barton et al., 2017; Calabrese Barton and Tan, 2018; Greenburg et al., 2020). This area of research has shown that long-term work with youth of Color and educators in some informal spaces has allowed for increased engagement with STEM and feelings of empowerment in

science. These opportunities often engaged youth not only in content-rich STEM making experiences, but specifically in community problem solving that allowed youth to make connections to their lives and what they care about.

Ong et al. (2017) found that STEM counterspaces, specifically those that act as safe spaces for women of Color, were deemed necessary for their participants because of isolation and microaggressions that the women faced in more mainstream STEM settings. The key features they found were important in STEM counterspaces were peer-to-peer engagement as well as opportunities for mentorship with those who have had similar experiences. Although counterspaces can exist within more formal education, the participants mentioned many informal opportunities that they had that contributed to more positive feelings of belonging in STEM (Ong et al., 2017).

Relevant literature from classroom education

The research specifically on informal science educator (ISEr) teaching, especially that focuses on equitable teaching practices, is limited. However, there is quite a bit of relevant research on White classroom teachers' interaction with youth of Color and how teachers can be culturally responsive in their classrooms. In one study, Warren (2013) suggests that empathy, or working towards seeing things from their students' perspectives, is a tool that can help White teachers work towards cultural responsiveness. More recently, Warren and Hotchkins (2015) added to previous work by arguing that empathy without examination through a critical race lens leads to false empathy. False empathy showed up in the classrooms of well-intentioned White female teachers and perpetuated the power and privilege of the White teachers and the silencing of marginalized voices in the classroom (Warren & Hotchkins, 2015). The author suggests that teacher preparation programs that incorporate a critical race lens is a tool that could be used to

help White teacher candidates examine how race and racism shows up in the classroom (Warren & Hotchkins, 2015). I argue that White ISErs, who do not often have a teacher preparation background, need a way to examine how their Whiteness affects their work and their interactions with youth, families, and communities.

Another relevant field of scholarship is that of racial noticing with preservice classroom teachers. Shah and Coles (2020) described racial noticing as including attending to racial phenomena, interpreting racial phenomena, and responding to racial phenomena. They argue this is a difficult and long-term process for White preservice teachers (PSTs), who have to change the way that they look at their interactions with students to notice race in a way that White people rarely have had to do in their lives. However, it is critical for PSTs, to notice the racial biases and deficit views that they may hold that will impact the learning opportunities of their racially minoritized students if they are not interrogated and actively pushed against (Shah and Coles, 2020). Again, Shah and Coles (2020) argue that teacher preparation programs are a place to engage PSTs in this work. So although ISErs also need to engage in this work, they likely do not have the same opportunities to do so.

Why outdoor educators?

Most of the research on equity in informal spaces discussed above occurred in museum spaces. Because outdoor learning spaces may have additional layers of historic racial discrimination that could make marginalized visitors feel unwelcome, informal educators, especially White ISErs who work in the outdoors with participants of Color, need to have more conversations about racial identity and Whiteness and how these affect their interactions with visitors in order to provide more meaningful experiences.

The first step in addressing this problem is to learn about informal educators' perspectives on DEI issues and how they might have opportunities or not to think about DEI. We know from the literature that individuals at institutions of science education have varied conceptions of equity (Feinstein and Meshoulam, 2014; Philip and Azevedo, 2017) and have most often engaged in efforts that address issues of access. This study examines the perspectives of outdoor educators around DEI, their perceptions of the extent to which DEI issues are addressed at their institutions and the barriers that exist to action around DEI, and what opportunities these educators have to expand their knowledge around DEI.

Research Questions

1. What are informal science educators' perceptions about diversity, equity, and inclusion in their learning spaces?
2. To what extent do their organizations support them in having conversations about and enacting changes around issues of DEI? What barriers exist to enacting these changes?

Theoretical Frameworks

Several intersecting frameworks guided this work, particularly the design of the survey and interview protocols. First, I will discuss some of the frameworks related to social justice science education, which have been used to think about equity and justice in science teacher education and classroom pedagogy. Then I will discuss a framework of Rightful Presence (Calabrese Barton and Tan, 2020), which was developed specifically with informal science spaces in mind. Then, I discuss how those informed the approach that I used in this paper.

Social Justice Science Education

Science education as a field has considered equity in many ways. Although research has long acknowledged there is a racial equity problem in STEM in the US, many still default to

deficit perspectives when discussing why students of Color, and in particular Black students, engage less in STEM courses as well as why STEM careers continue to be White and male dominated fields (Butler et al., 2013). These deficit perspectives lead to assumptions that the way to fix the problem is through assimilation of a Western Modern Science (dominated by White, male perspectives) way of knowing and doing science (Mutegi, 2011). Not only are historically marginalized individuals often not represented in the science field, but science teachers often perpetuate this marginalization in their classrooms when they present science as separate from culture and therefore do not consider cultural contexts (Butler et al., 2013; Mutegi, 2011). Positioning Western Modern Science, which is Eurocentric, as the only valid way of knowing and doing science leads to the erasing of marginalized students', particularly Black and Indigenous students', epistemologies (Bang, 2017; Mutegi, 2011)

Scholars have also used culturally relevant (Ladson-Billings, 1995) and culturally responsive (Gay, 2018) teaching as frameworks for thinking about equity in science education. Key to both frameworks is the framing of student culture as central to science teaching and views students' multiple identities and funds of knowledge as assets. In science education, scholars use these lenses to push against dominant science narratives by asking questions such as "how do you open science through your teaching practices, rather than making students assimilate into the culture of science that often neglects and alienates their full participation?" (Mensah, 2021, p. 12).

Also relevant is the work of scholars who think critically about Whiteness in science teacher education. This work informs how the identities of the ISErs might affect their interactions with students and their perspectives on science and equity. Retention of teachers of Color, particularly science teachers (and, I argue, informal science educators as well) is a huge

problem in the field (Mensah & Jackson, 2018). With a student population increasing in diversity, the disparity between the race and ethnicity of teachers and their students is only getting larger (Mensah & Jackson, 2018). There is an "overwhelming presence of Whiteness" in education (Sleeter, 2001, p. 11). The reification of Euro-centric Western Modern Science as the only valid way to know science is consistent with critical scholars' thoughts about Whiteness as property (Harris, 1995; Mensah & Jackson, 2018) and specifically how science has been treated as White property. In other words,

> the right to use and enjoyment of science—what science looks like, who engages in science, and what science is for—historically has meant a disregarded and exclusionary view of science where women and people of color with their indigenous knowledge, and cultural frames of reference do not have a right to use science or enjoy it. (Mensah & Jackson, 2018, p. 9)

This historic exclusion of Black and Indigenous people from science has been explicit and purposeful, as marginalized groups were not allowed to make contributions to science and when they were, they were not recognized for their contributions or their contributions were stolen by White colleagues (Mensah & Jackson, 2018). It has also been implicit, often hard to see particularly by White teachers who are teaching within an educational system that also upholds Whiteness, likely teaching a curriculum that upholds Western Modern Science, and reifying science as a neutral, objective, and acultural subject.

Rightful Presence

More specific to some of the research in informal science education that suggests that historically marginalized communities do not feel like they belong in informal science spaces, Calabrese Barton and Tan's (2020) framework of Rightful Presence addresses this problem. This

framework goes beyond teaching practice to think about how various systemic injustices have all contributed to these feelings of being othered in science spaces. Echoing some of the research in informal education as well as the frameworks above, it calls for moving beyond inclusion so that students not only are included in activities or given access to science, but can feel like they belong and their experiences and knowledges are valued without having to assimilate to the dominant narrative, which is often Whiteness (Calabrese Barton & Tan, 2020). The authors argue that rightful presence requires disruption of this dominant narrative of science, and in the context of this study, ISErs need to understand these issues and create spaces in which youth no longer feel othered.

Study Design

This study is a two-part exploratory survey and qualitative interview study. Below I will detail the participants and context, study design, and data analysis.

Participants and Context

This paper focuses on informal science educators in a large Midwestern state who work, at least in part, with PreK-12 public school students from urban communities. The survey was sent out via several informal science education listservs as well as shared over social media and between colleagues. After eliminating survey participants who did not finish over 70% of the survey, 48 individuals remained in the survey pool. Interviewees were chosen because they expressed an interest at the end of the survey in participating in a follow-up conversation. All participants who indicated they were interested were reached out to and I scheduled interviews with all who responded. I interviewed seven individuals (Table 1), three who identified as female (all were White), and four who identified as male (three were White and one was Black).

Table 1. Interview participants' self-identified professional identity, race, and gender

Pseudonym	**Professional Identity**	**Race**	**Gender**
Greg	Interpreter	White	Male
Ben	Zoo educator	Black	Male
Beth	Informal/outdoor educator	White	Female
Teresa	Farm educator	White	Female
Adam	Interpreter	White	Male
Jeff	Interpreter	White	Male
Lori	Naturalist	White	Female

Data Generation and Analysis

Survey

The anonymous survey consisted of 25 questions that were a mix of multiple choice, Likert type, and short answer (Appendix A). The survey questions were developed considering the literature on DEI in informal spaces, the framework of rightful presence (Calabrese Barton and Tan, 2020), as well as my own and colleagues' experience in the field. The survey included questions regarding demographics of the ISErs themselves, the visitors to the organization, and their organization's staff and management. It also included questions about their perceptions of what their organizations are doing around issues of DEI and what efforts are most important to the ISErs. In particular, relating to the framework of rightful presence (Calabrese Barton and Tan, 2020) and the literature I discussed above about moving beyond thinking of equity as access, I created survey questions aimed at figuring out the participants' own ideas about equity. For example, I asked participants what kinds of efforts for their organization and the field were most important to them and why. Allowing them to both list the efforts as well as expand on

them gave me insights into how they viewed equity. I also asked what their organizations were actually doing around these important efforts, which allowed me to compare the educators' priorities with the actual work that their organizations were doing. I also asked participants about their perceptions of the barriers to implementing DEI initiatives in their organization and what opportunities they have to learn more about DEI.

I analyzed survey data through simple statistical analysis for the multiple choice and Likert-type questions. For the short answer questions, I conducted two rounds of qualitative coding (themes and codes came from participants' written ideas).

Interviews

From the pool of 48 survey participants, I interviewed seven participants in 45-minute long semi-structured interviews (Appendix B). Again, these interview participants were chosen because they indicated their willingness to be interviewed and responded to set up a time for the interview to take place. In these interviews I asked participants about their journey into informal science education and what they loved and found challenging about their jobs as an ice breaker. Then I asked about what kind of programming they did with public school groups, about their interactions with students of a different racial identity than themselves, efforts their organization has made around DEI, barriers around DEI, what kinds of efforts they would most like to see happen, and if they could elaborate on any specific training or further education opportunities they have had. I analyzed interview responses using the qualitative data analysis software MAXQDA2022 (VERBI Software, 2021). Through two rounds of qualitative coding of both survey short answers and interviews, I identified salient themes that I will elaborate on below.

Findings

Findings are drawn from survey and interview results. Forty-eight individuals completed at least 70% of the survey. Seven of these survey participants were then interviewed to understand their perspectives more deeply. Survey participants indicated on the survey if they were willing to participate in an interview. I reached out to all respondents that indicated that they were willing and the seven that were interviewed were participants that responded and set up an interview time.

Identities of ISErs

Out of the 48 survey participants, 42 (87.5%) identified as White, three identified as Black and Indigenous (one of whom specified Choctaw and Anishinabe), one identified as Middle Eastern, one identified as Asian, and one did not specify. When asked about their gender identity, 32 (66.7%) identified as Female and 16 (33.3%) identified as Male. The identities and pseudonyms of the seven interview participants can be seen in Table 1.

In terms of their professional identities, in a multiple answer question most participants chose multiple identifying titles. Overall, 18 identified as informal science educators, 11 as non-formal science educators, 18 as interpreters, 22 as outdoor educators, 20 as naturalists, and 1 as a museum educator. Many also wrote in specific positions such as zoo educator, farm-based educator, teacher educator, environmental education coordinator, program manager, 4H leader, and nonprofit educator. Despite these many professional identities, for simplicity I will continue to call them informal science educators as that aligns with the research base on out-of-school science learning; even when targeting ISErs who work specifically in the outdoors, there are a large number of professional identities represented and out-of-school science learning spans across many contexts.

When asked how they would describe the demographics of their place of work (including race, gender, ethnicity, ability, etc.), participants primarily mentioned race. 34 (70.1%) said the staff at their site were majority White, while seven (14.6%) said they were racially diverse. Four participants did not specify or said the question was not applicable, one said "not diverse," one said the racial demographics were reflective of the state, and one said all staff were White or Black. In the same question, 32 survey participants mentioned gender identity. Out of those 32, 21 (65.6%) said the staff were mostly Female. Thus, the majority of the survey respondents as well as the other staff at their sites of work identified as White women.

Identities of Visitors

Overall, ISErs reported higher diversity of visitors than of staff, particularly racial diversity. 77.1% of the ISErs said they work with PreK-12 public school students from urban areas, which typically have higher racial diversity than suburban or rural areas. When asked about their perceptions of the racial identities of the PreK-12 students they work with, 19 said they were mostly White, 16 said that they were from a diverse range of racial identities, six said they were mostly Black or African American, two said they were mostly Native American or Indigenous, two said participants' races reflected the state demographics, and three did not specify anything to do with race.

Several Likert-type questions also focused on participant identities (the survey defined diversity in terms of race, gender, socio-economic status, etc.). When asked to respond to the statement "my organization has participation from a diverse audience," 73% chose "somewhat agree" or "strongly agree." However, when asked to respond to the statement "my organization has a diverse staff," 56% chose "somewhat disagree" or "strongly disagree."

Some participants chose to elaborate on their answers. When talking about PreK-12 program audience identities (including race, gender, and socio-economic status), one ISEr stated that they are "far more varied than our educators (including indigenous, non-white, age, finances, etc). Our program is reliant upon support from volunteer educators who are retired, financially stable, and generally unfamiliar with the struggles of folks with demographics different from them."

Recognizing DEI Issues in ISE

The participating ISErs recognized many problems around DEI in the field and their organizations and noted the lack of meaningful changes most of their organizations have made. When asked what efforts were most important to them in their work, the most common answer was to increase participant belonging (mentioned by 20 respondents), the second most common answer was improving access to the site and/or accessibility (mentioned by 19 respondents), and the third was increasing staff diversity (mentioned by 8 respondents).

Participant Belonging

When discussing participant belonging, some survey participants specified what they meant by this. One wrote "I want them all to feel like there is a place for them in nature and science." Another wrote she would like to "increase comfort in the outdoors and in agriculture, and help our participants feel that the farm is a safe and welcoming space for them." Some also thought specifically about culture, mentioning that they wanted to improve by providing "programs that reflect culture" or "culturally appropriate programming." One specified "our organization is dependent on our participants and funded through participants, therefore, our programs must be developed with our participants' cultures in mind so we can meet their needs more completely."

Interview participants also mentioned participant belonging or participant culture, particularly in thinking about how building more meaningful relationships with participating students helps them feel more comfortable and welcome in the space. For example, Teresa, a White female farm educator, said "my approach as an educator is to, I want to know enough about something that interests generally your group… being able to connect with some kind of cultural, or activity connection, I think is important." Ben, a Black male zoo educator, talked a lot about what he felt his White colleagues did not understand about the majority Black student population that visited their site. He said "what those educators that are not of Color need to do is to work harder to learn about the culture of these kids." Later in our discussion, he brought this up again when he discussed times his primarily White colleagues have expressed difficulty in relating to visiting students. "[ISErs] will say 'well the kids aren't really relating to me.' Well you're not relating to them either… until you show them you respect their culture, why should they?"

Access and Accessibility

Increasing access to and accessibility at their sites was the second most common answer to what efforts were most important for ISErs in the survey. One survey participant wrote, "if we want everyone to be stewards, then we need to ensure everyone has access to the outdoors no matter what challenges may present for individuals." Responding to the question asking what effort was most important to them, another wrote, "access because education can open doors and lack of money shouldn't hurt educational opportunities."

Adam, an interview participant and interpreter at a park, noted access as one of the most important issues to address DEI at his site. Although he recognized that the rural location of his site was a primary barrier, he said that school group visitation has dramatically decreased in

recent years, even before the COVID-19 pandemic, and particularly from schools in lower socio-economic status communities, including some of the rural communities near his park. He said, "We got a lot of poor areas in [our county]... and I don't see them at all, and I tried to make contact with them…I try real hard to reach out to those teachers in those districts and say, I'll come to you and I never get a response from them…I don't know their situation. I can imagine what it's like when you don't have the resources."

Staff Diversity

Many ISErs noted that they felt it was a problem that their organizations were mostly White, especially those that worked with youth and families of Color. One survey participant wrote simply, "we see the need to hire Black educators if we continue to go into Black communities, but have yet to." Another ISEr echoed the need for more staff of Color by writing in the survey, "We work with a lot of young people. I think the most powerful thing we can show a young person is "someone like me" doing this kind of work."

In an interview, Adam said, "you go to meetings where you have the whole Parks and Recreation division there. And, and you might see a couple, maybe one or two or three African Americans, you look around, you might see maybe two or three Hispanic people… everyone else is White." As someone who had been in the field of interpretation for a long time, Adam did feel that the parks system has done a better job of increasing gender diversity when he said, "Yeah, I do have to say, when I started 33 years ago, 34 years ago… it was all male, White male. It was, and then we hired two female park managers. And that was big news. But now you're seeing a lot more females in the field, which is great." However, he clarified that although there were more women entering the field, management or supervisory positions in the field were still male dominated.

Teresa also discussed staff diversity at the farm that she worked at during her interview. She talked about how the school groups that attend her programming are predominantly Black and that the staff is entirely White women. She said, “we're very much aware that it's like, we're the nice White ladies, you know. And I feel like there are a lot of nice White ladies who are in a position to be able to afford to do nonprofit work to be able to afford to do teaching work.” In this quote she is noting one of the difficulties that many ISErs in the survey and interviews echoed - that informal science education (like classroom teaching) is an underpaid field and that it is often individuals who are in privileged positions socioeconomically who are able to do that type of work. Teresa discussed that they have made efforts to reach out to Black farmers’ networks and through other community channels when hiring for positions, but so far their applicant pool has been predominantly White.

Beth, whose programming relies heavily on volunteers, discussed in her interview that not only was having an all White staff a problem because students of Color aren’t seeing people who look like them, but also because of the racial biases that her White volunteers hold and sometimes express implicitly or explicitly. One example Beth gave was the volunteers’ casual use of the phrase “dock rats” to refer to low income people who work at the docks. I asked Beth if she saw a difference between how staff at her organization interact with students who are the same racial identity as them versus a different racial identity. She said, “yes, and embarrassingly, so… by and large, our staff are old White men and women who are far higher socio economically… that's a really difficult disconnect when you're trying to reach some of these kids from the country, like, from 20 minutes away, that are poor or our local indigenous community. There are offhand comments that get made, usually out of earshot of the kids, but like, there are things we have to address all the time.”

Ben, the director of education at a large zoo and a Black man, talked about hiring extensively in his interview. Although the education staff at the zoo is more diverse because he is in charge of hiring and makes an effort to hire people who are representative of the population they serve, the rest of the zoo staff is mostly White. He said, "when you go to a zoo, the first thing you want to see is animals, right? So now, if you see all these animal care staff walking around, and none of them look like you, you would think that's not an opportunity for you."

Most of the ISErs have awareness that there are systemic inequities that the field of informal science education needs to grapple with. Some have greater awareness than others. For example, several seem to think it is simply an issue of access, but overall they notice and want to solve the problems they see in their field around DEI. However, when describing the actual efforts that they or their organization have implemented, most did not address any underlying systemic issues, particularly around participant belonging despite that being the most important issue to the ISErs.

Efforts around Inclusion

Despite participant belonging, access, and staff diversity being the three most important items cited by the ISErs in this study, when asked what actual DEI efforts their organizations had implemented, their survey answers revealed a bit of a different story. In a survey question where ISErs were asked to check all of a pre-set list of efforts their organization was working on, the three most commonly checked efforts were "physical accessibility" (82.5%), "making sure that program participants feel like they belong at our site/organization" (82.5%), and "access to site (including transportation and entry costs)" (65.0%). Notably, the least common answer was "diversity of management," which only 20.0% of respondents said their organization was making

efforts around. 52.5% responded that their organization was making efforts around diversity of staff.

However, despite relatively high numbers of participants checking boxes that stated their organizations were engaging in efforts around physical accessibility, participant belonging, access to the site, and staff diversity, they were also asked to "describe any efforts to increase diversity, equity, and inclusion that you or your organization have implemented." When survey participants had to write down the actual efforts their organization has implemented, those answers revealed much more shallow efforts. Specifically, despite 82.5% of respondents checking the box that said their organization was working on efforts around participant belonging, none of the specific efforts they listed addressed this in any direct way. Instead, their organizations primarily seemed to focus on access and accessibility, providing non-required training and webinars, or very specific but low-effort inclusion efforts if anything at all. When getting more detail from the interview participants, their answers mostly seemed to echo these efforts, but also noted a few more specific hiring efforts to increase staff racial diversity. This pattern again shows a focus on surface-level efforts that do not address systemic issues of equity.

Access and Accessibility

When asked in the survey to "describe any efforts to increase diversity, equity and inclusion that you or your organization have implemented," many ISErs described specific access or accessibility efforts. Several of them focused on the cost of programming for participants, saying things like they were "trying to make admission free and cost lower for people to participate," "trying to make our programs accessible as possible for all groups by providing free programming and transportation," or providing "camp scholarships for camp participants and affordable contracts for public schools."

Interview participants also discussed more specific efforts around access. Beth, who works on a ship, discussed that one of their efforts to address the issue of access was to take the ship to the nearest port for students in an urban district instead of making them travel further to where the ship is usually docked. They have also provided reduced price programming through grants and not requiring as many chaperones for field trips which she noted could be a barrier for access for school groups. Lori, a naturalist at an outdoor center, discussed a recent effort at her organization to do more outreach and go to schools since access to their site seemed to be a problem for schools. She said "we know transportation is an issue for a lot of schools, time is an issue for a lot of schools, and funding is an issue for a lot of schools." Adam, an interpreter at a state park, echoed these concerns about school groups struggling to access his site. He suggested that even when financial barriers were addressed, such as bussing costs, schools and teachers still seem to have less time for things like field trips than in the past. He stated "we tried a busing stipend here and it didn't work…. We saw our numbers still go down. A lot of it has to do with testing now… all this testing that students go through in school now, they moved the testing to this month now, and that was our prime time with school groups."

Others focused more on accessibility, primarily physical accessibility of their site, but also accessibility for neurodivergent participants and web accessibility all of which addresses the goal of having more people being able to access programming. For example, one survey participant wrote that their organization had made a "strong push for accessibility of documents, website, etc." Jeff, an interpreter at an outdoor education center, said in his interview that his organization had made a lot of specific efforts around accessibility including paved walkways and providing noise canceling headphones for visitors with noise sensitivity as their site can be quite loud. Access and accessibility were one of the primary concerns of many ISErs and their

organizations. Greg, an interpreter at a park said in his interview, “we don't have automatic doors. And if you are in, in a chair, it's hard for you to open that door and get yourself back in. So we want to have the push button stuff. Well they're super expensive, with the money that we're getting from the [government]… that's one of our main priorities is to say, look, we need automatic doors, because it's not fair.”

DEI Training

Several survey respondents mentioned efforts their organization has made around providing opportunities to learn more about equity through in-person training, online resources, and webinars, but their responses in addition to interview responses indicated a wide range of experiences that ISErs saw as more or less useful to them. Some survey participants noted that their organizations had staff that were hired to work on DEI initiatives and training. For example, one said their organization had a “DEI committee and onsite staff [who are] responsible for our DEI initiatives, trainings, involvement with all staff.” Another wrote that their organization had a “DEI speaker series.” Others noted that online information was made available to them, but it was not required or even incentivized to use that information. For example, in his survey response, Craig wrote “The [organization] offers webinars and other electronic opportunities.” Since he was also an interview participant, I got to ask him more detail about these opportunities, which he clarified are not required, but just offered if ISErs are interested. In addition, although there are remote options available sometimes, there are also in person meetings through the larger organization but they do not occur near where he lives. He said, “there's opportunities out there for me. And if they coordinate with my schedule, I usually go in and sit through them.” His phrasing here suggests that he is not actively participating in these trainings or seeking them out, but simply attending if it easily fits with his schedule.

Jeff also noted similar experiences with DEI learning opportunities during his interview. He said, “it wasn't necessarily a lot of professional development training, it - from what I could see from their offerings, it was presentations… and they had articles sometimes about different things…I know, during African American month, they had different presenters. So they had webinars that you could attend. At the time, I wasn't full time, so there was no compensation.” Jeff implied that he did not frequently attend these learning opportunities, in part because there was no compensation or incentive to do so.

In contrast, Teresa, a farm educator with a larger health organization, did note during her interview that her organization had required DEI training that she found somewhat useful. However, it had more of a healthcare focus since it was an organization-wide training. She thought it was a bit shallow and when I asked what would be more useful she said, “what I really want is, you know, some cultural competency tools around like, I know that I'm not the only - I may be the only farm educator within [organization]. But I'm not the only person that works within a community that is predominantly of Color. And so where are the resources for those of us who do that to come together and say, you know, tell us about your experiences, and let's learn from each other?” Here, Teresa is expressing an interest in higher quality and more critical learning opportunities, showing an awareness of her need to learn from the experiences of others as a White woman working with a community that is predominantly of Color.

Limited Initiatives

Many survey respondents also mentioned very specific, low effort initiatives, such as “pronouns on nametags,” “inclusivity statements on website,” “land acknowledgements,” and “a couple blog posts.” Others mentioned specific holiday initiatives, such as “diversity day,” and “outreach efforts around PRIDE month, Women’s History month, Black History month, Native

American Heritage month." These suggest that inclusivity efforts of this type only happen during specific times of the year.

In addition, four survey respondents said their organizations were not doing much at all to address issues of DEI. One participant simply wrote, "I have not seen or participated in any efforts to increase diversity, equity, and inclusion in my organization." Three wrote about a few small things, but with an undertone that suggested they felt their organization wasn't doing anything. For example, one wrote, "hire on one staff member to try and focus on everything DEI" and another wrote that the only thing their organization had done was a "proposal for woman-centered programming that has not seen fruition."

Staff Diversity

Although it wasn't brought up as often as a specific effort in the surveys, some answers revealed efforts around increasing racial diversity of staff or frustrations around hiring challenges their organization has faced. Some interviewees discussed specific efforts their organization has made and how it has been successful or not. One survey participant wrote "flexible PTO/holiday policy" as a DEI effort, suggesting that it was put in place as an effort to make positions more accessible to a broader range of people. Another said their organization was, "changing the way we advertise jobs, reaching out to HS students to let them know we have careers for them."

Beth, who I discussed above as relying heavily on volunteers who tend to be older White men and women, mentioned in her interview that for summer programming they hire interns and the organization made a particular effort in recruiting an intern of Color. She said,

> We also intentionally hired a Person of Color intern - like we recruited pretty hard to, to make that happen. And he's a grad student from [university]. And, like, so we did that intentionally with trying to get him on to those programs where we knew kids would be.

> And part of his internship as a grad student…was to design a station that connected to those urban populations. So his was specifically about what is your relationship with water? Like how do you identify with, you know, the water around you. And so it was way more social science, but it was really well received, and the kids like, you know, opened up in a beautiful way.

Although it wasn't directly part of the conversation, it was clear from my interview with Ben that his position as director of education at the zoo was extremely important in terms of hiring more educators of Color in the education department. Being a Black man in a management position allowed him to have a positive effect on the rest of the department, which is especially notable since the survey responses revealed that efforts around increasing the diversity of management were not common.

Additional Barriers to Action

In addition to the barriers that ISErs noted above regarding the challenges most important to them - participant belonging, access and accessibility, and staff diversity - participants also discussed some additional barriers to implementing change in their organization. Below I discuss several additional barriers raised by ISErs.

Material or Human Resource & Capacity Barriers

One of the most commonly mentioned barriers to implementing change around DEI within their organization in both survey data and interview data was a lack of funding and/or a lack of resources like staff time and energy. When asked what barriers exist to implementing DEI initiatives, one survey participant simply wrote "funds and time." The same participant when asked what more their organization could do to support DEI wrote, "more funds to expand staff to allow for diversity. Time for staff to reflect and revise programming to be more culturally

appropriate." When writing about barriers, survey respondents wrote things like, "there needs to be more grant funding for the outdoors, "financial support," "finding grant support to fund our programs," and "cost of implementing [DEI initiatives]." In her interview, Lori, who works at a state-funded site, discussed the challenging process of getting funding, especially to make more systemic changes. She said,

> There's bureaucracy to deal with, oftentimes, more in terms of 'hey, we want to get this training. Do we have the funding? Can we go through all the hurdles to do stuff like that?' or, 'Hey, we need to buy these supplies.' That's usually not too bad. If it's something more like, 'Hey, we have to change this structure'... That takes a lot more than just our staff, we have to go up several levels to get things done."

Resources like time mentioned above and also emotional bandwidth were brought up as well. One survey participant wrote "Staff & Board bandwidth. We are a small group with limited resources. We have existing obligations to our community so the idea of implementing radical change without completely changing the way we do business is sometimes daunting." Beth discussed at length in her interview the emotional toll that being the one staff member that always brings up DEI at meetings can take. She said that DEI is "something that needs to be embedded into everything and something like, you need somebody for it to be their soapbox, for it to come up repeatedly in meetings. And it's like, unless you have the emotional bandwidth to take that on, it doesn't matter who's wearing the [DEI] hat or how well intentioned any of us are when our bandwidth for that is low." She added later that a lack of time and resources given to DEI added to that emotional bandwidth challenge. Since it was not something that is necessarily embedded in the mission of her organization, it requires staff to take it upon themselves to do extra work that is not compensated or incentivized to make it a priority. She said "I don't think

anybody here has the bandwidth to spend an extra 15 minutes before every meeting, looking at every topic from a DEI lens."

Structural and Cultural Challenges

Another type of barrier that survey and interview participants discussed was organizational pushback, especially from those holding positions higher up in the organizational hierarchy. ISErs, who were not in positions of power within their organizations often had different opinions than those in leadership positions. One survey participant wrote that a barrier to implementing DEI initiatives was "upper management not wanting to be 'controversial,'" suggesting that the politicization of DEI has caused this ISErs organization to be hesitant or unwilling to implement change. Another wrote that they had experienced, "some pushback from older employees as well as from older members of our Board of Commissioners." The perception that older staff or management were unwilling to make change was a theme. Another survey participant wrote that one barrier they had experienced was, "old white men stuck in old ways." Yet another wrote, "good old gal/boy hiring their friends and family. We want DEI as long as it does not hurt our family and friends."

Discussions around power came up both implicitly and explicitly. A survey respondent wrote "I do not hold a leadership position and am only here temporarily." Seasonal positions are extremely common in informal science organizations, and those employees may not feel empowered or motivated to make change. Even some ISErs in leadership positions felt they did not have the skills or experience to address DEI issues. For example, Adam who has been in the field for over 30 years and is lead interpreter who manages other educators said in his interview, "there's just all kinds of issues that I… I'm not the smartest person in the world to solve those problems." He sounded defeated when discussing the idea of making changes around access and

inclusivity at his park, and others seemed to echo some of that hopelessness or the feeling that they were not knowledgeable or empowered to address issues as big as equity.

Some survey and interview participants talked about larger systemic issues in the field, not just in their organization, particularly around the politicization of DEI and how many avoid difficult conversations around race and equity. One survey participant wrote,

> DEI is such a broad topic that can include so many disenfranchised members. Some people feel as though we should call out each and every group with an explicit invitation to programs whereas others feel as though that act would be pandering and in turn excluding out other groups for that event. People are also afraid of DEI discussions for fear of offending someone rather than framing an inquiry as an opportunity for growth.

Lack of Knowledge About Students and Communities

Another theme that I noticed analyzing surveys and interviews is that ISErs do not have much time to get to know students and their interests in the short-term programming they offer. Unlike classroom teachers who have the same students for a year, ISErs are often only with a group of students or family visitors for a few hours or maybe a few days if their programming is overnight. This means they are most often unable to modify programming in meaningful ways to meet student interests or needs. One survey participant wrote, "we don't know anything about the group before they arrive at the site. We meet the bus and start the program from there." This makes responsiveness to student interest and cultural responsiveness difficult. Another wrote, "we do not have much time to get to know them while we're teaching their program."

Those that are more able to be responsive in their programming often gather information about students' interests and needs primarily from teachers or prior classroom visits. One survey participant wrote,

> I often go to the students rather than them coming to me. If they are coming to my organization, I've already met with them in the classroom beforehand to give them some background on what they're doing on their trip. When presenting to the students, I like to ask a lot of questions to gauge their existing knowledge and their interests, and modify my presentations around that.

In his interview, Ben discussed with me in depth about how he felt his White colleagues often did not have knowledge of the cultures or communities of the majority Black students that visited the zoo. He felt that as a Black educator that grew up in the community, he was able to connect to students and understand their interests, needs, and cultures easier than his White colleagues. He suggested that the most important thing for them to do was to spend time in and get to know the community. He said, "when you live in a community, you feel a part of that community… if you want to feel part of [city's] culture, you wouldn't come listen to a talk about [city's] culture." For his fellow colleagues He expanded on this idea later when he said,

> You know, if you're really interested in helping a community, or if you're really interested in helping a group of people, then you have to learn as much about them as you can. And my grandmother used to always say, the good Lord gave you two ears, and one mouth. So you should listen twice as much as you speak… you are here to listen to the community, and to work as a part of the community. So you walk along with them, you know, you have a conversation with them… they will much more appreciate that than if you come on down there saying like, 'Oh, I am an expert and this is what you know, we need to do.'

As these data show, not only do ISErs face a problem of not being made aware of the backgrounds of their visitors, particularly student group visitors, but they also often are not

knowledgeable about the community suggesting that even if they were made aware of this information, would they have the cultural knowledge to be responsive to the needs or interests of these students in a meaningful way?

ISEr Language Around DEI

Although ISErs as a whole expressed that they care a lot about efforts around DEI, there were some implicit biases that showed up for many while they talked about inclusion efforts. As I analyzed the survey and especially the interview responses, I noticed that some of the language that ISErs used to talk about DEI revealed some patterns of how they think about race. The most common problematic views or language that came up in my discussions with ISErs were deficit views of students and/or families of Color or low SES communities, colorblind views, and using race avoidant language.

Language Which Reveals Deficit Views

Some deficit views, particularly of low income students and families and/or students and families of Color, were apparent in the ways that ISErs talked about participants in surveys and interviews. A very common deficit view held by ISErs is that student discomfort at their site, particularly in the outdoors, was due to the students' culture. This discomfort was seen as something they aimed to "fix" by being friendly or providing students with more knowledge about the outdoors. For example, one survey participant wrote, "some cultures are less apt to allow their female children to go to camp or outdoors events, they also are less likely to allow them to go places alone and so much can be learned with independence." In addition to this being an inaccurate and racist assumption of a group of people, this way of thinking does not allow for any introspection about how practices of the informal institution may lead to

participants feeling uncomfortable or unsafe at their site, but instead incorrectly puts the blame on a community suggesting they need to change their practices.

A survey participant also revealed similar views when asked how they get to know students that come to their site. The participant wrote, "we generally welcome everyone equally, unless we know they are from a very urban area like [city name]. Groups from [city name] are much more hesitant to be in nature or feel comfortable exploring it." The city this participant is referencing has a predominantly Black or African American population. So although many ISErs did not directly reference race in their comments, they are indirectly making deficit statements and assumptions about Black visitors when talking about visitors from this city.

Greg made similar comments in our interview. About visitors from more urban areas he said, "if they're from an urban area, they're not comfortable with the woods or the forest. One of the first questions I get is 'are there bears here?' Like, 'yeah, we've got bears here', and then they stop and I'm like, 'not here, here, but over there in the woods.'" Again, this generalization about visitors from urban areas is a deficit view which reveals what seems to be a common assumption amongst ISErs that their visitors of Color, specifically those from urban areas, are uncomfortable in nature and the ISErs can "fix" this by simply explaining that it is safe.

Language Which Ignores the Importance of Race

Several ISErs used language which seemed to ignore the importance of race in their context or in what seemed like an effort to avoid discussing race. Some ISErs held colorblind views when it came to race, believing that they treat all participants or visitors to their sites the same, which suggests they believe race is not relevant to their context. These views primarily came out in the more in depth interviews. For example when asked in her interview if she feels like her racial identity affects her interactions with students who have a different racial identity,

Lori, a White woman who identified herself as a naturalist, said "I honestly don't know. I don't think about it a whole lot. I don't know if that's a good thing or a bad thing. I tend to approach people as people, kids as kids." Similarly, when asked the same question, Jeff (a White man) said "not really. Well, I can't personally say for the students that come or the public that comes, all I can say is… I try to be authentic and real with them."

One interviewee, Greg (a White man), spoke about these views using racist language which directly contradicted what he was saying:

> I'm originally from the [large city] area, and so I grew up in a somewhat - well, the neighborhood was white, but I went to school with many different ethnicities, right? And so I've always, I've always been around that. So to me, when I meet somebody colored, or what have you, I don't treat him any differently. Because I've been exposed to him. I, my personal opinion is that my colleagues who have not grown up in that situation would have had a little bit more of like, how should I deal with this? Well, I don't, I don't deal with it any different than anybody? Just because that's me. That's how I was raised.

Greg's views on treating everyone the same also showed up when talking about the programming he does at his site. For example when asked about the flexibility of their programming to address student interests or teacher needs, Greg said "well, I don't know if we can create a whole new program for them, because what we're doing works. And so we really haven't done anything else."

Several ISErs also used language that seemed to purposefully avoid talking about race. One common example was ISErs using the term "urban" as a euphemism for "Black" when talking about people. In addition, despite our conversation being framed as a discussion around

DEI, most interview participants had to be pressed to bring up race and racism as a topic of conversation and many were uncomfortable during that part of our discussion.

Discussion

As awareness has grown about the inequities that science education and especially informal or outdoor science education can perpetuate, it is clear that study participants have thought about DEI and what efforts they and their organizations might make. Most also stated that their organizations have had and encourage discussions around making changes that address DEI concerns. The data make it clear that many also care deeply about equity and recognize inequity in their work and organizations. However, the systems that they work within are most often inequitable ones and, in many cases, ISErs do not feel they have the agency to make meaningful change, whether that is because of power dynamics and lack of support by their organization, a lack of knowledge about DEI or the communities that they serve, or human capacity issues or material resource barriers. Agency, according to Bandura (2001), must involve the recognition of a problem, the planning of an action to address the problem, and the enactment of that plan; awareness and desire for change are insufficient. In the next sections I will discuss how ISE organizations and the culture of informal science education resist the kind of systemic change necessary to promote DEI and to integrate ISErs and their work into the communities they serve.

Belonging over Access

Echoing prior research, the ISEr participants in this study and their organizations as a whole seemed to focus their efforts on increasing access and accessibility while ignoring underlying inequitable systems. In order to move toward increasing rightful presence (Calabrese Barton and Tan, 2020), efforts must go beyond access to address participant belonging. As we

saw from survey and interview responses, ISErs cared deeply about their participants feeling welcome and like they belong at their sites. It was the most common response to the survey question about what efforts were most important to the ISErs. However, almost none of the actual efforts that ISErs said they or their organization were doing actually addressed underlying systemic reasons why their participants, particularly their participants of Color and those from other marginalized groups, might feel unwelcome. Instead, ISErs seemed to think small efforts around access and accessibility also addressed participant belonging. This also echoes prior research that suggests ISErs see their programming as inherently worthwhile for all and the communities they work with as lacking in some key understandings about the natural world and being the grateful recipients of the knowledge and experiences they can provide, a deficit perspective (e.g. NRC, 2009; Dawson, 2014b; Feinstein and Meshoulam, 2014). Equity, therefore, consists solely of the process of lowering barriers for participation so that visitors can access that knowledge and those experiences.

This stance does not address participant belonging in any meaningful way. Ignoring the historic and systemic oppression that science and science education has perpetuated further marginalizes participants. "Rightful presence asserts that legitimately belonging in a place, whether it be a sanctuary city or, as we discuss later, a classroom, centers *making present* the political struggles guests embody and experience." (Calabrese Barton and Tan, 2020, p. 434). Part of addressing participant belonging includes ISErs' need to think deeply about their own racial identities and how their practices, their implicit biases, and the practices and biases of their organization might uphold dominant narratives of Whiteness (Gosalvez, 2020). We know that one big reason that this doesn't happen is that those who are in charge of inclusion efforts are largely those who because of their identity are unaware of or ignorant to the underlying cultural

biases that informal science spaces can perpetuate (Bevan et al., 2021). Therefore, education opportunities for informal science educators are essential to solving this equity crisis.

Professional Learning Opportunities

One way to begin addressing this is for ISE organizations to provide more opportunities for further learning and discussion, higher quality professional learning opportunities, and financial support for ISErs pursuing further learning opportunities. We learned from our participants that not only are professional learning opportunities around DEI few and far between, when they do exist, ISErs rarely found them useful or thought provoking. Unsurprisingly, a lot of the specific examples of opportunities that ISErs said they did take advantage of focused on access and accessibility. As Teresa stated in her interview, even though she works for an organization that does provide DEI-specific training, she still felt like she was lacking deep meaningful discussions about culture, specifically within her community. Because most work that aims to disrupt educational inequity is restricted to university preservice teacher education and since most ISErs do not have this background, such work needs to be done through "inservice" professional development.

Another significant issue that arose in interviews was a lack of support (financial and time/space) for helpful professional development opportunities. Most expressed that any additional learning needed to be self-motivated, on their own time and with their own funds. Although some ISErs said they were encouraged to use time during their work day to explore these opportunities, no participants noted financial compensation for further learning opportunities, whether in paid time off, a stipend for professional development, or payment for time spent in further learning. Even if opportunities were made available to the ISErs, there was little incentive to participate in these opportunities. A lack of funding or support for further

education around equity indicates that this is not a priority for these informal science institutions and if equity is not placed as a high priority for organizations, equity efforts often only occur when extra funding is available (Feinstein, 2017).

Power Dynamics

As we learned from ISEr participants in this study, there are often differing opinions between on-the-ground educators and upper management who set these priorities in informal institutions. DEI has become a controversial and politicized topic in the United States and many ISEr responses suggest that conversations around DEI are often discouraged or even shut down. Even when upper management is supportive, some ISErs suggested there was a fear of upsetting participants who may disagree with DEI because of the politicized nature of the topic. Some ISEr participants suggested that those in leadership positions are resistant to efforts around DEI due to this. For example, Beth explained that her organization is run with the help of volunteers, who are often wealthy, retired, White individuals who she expressed have often said ignorant and offensive things. However, they rely on these individuals to be able to do their programming and so she is encouraged not to upset them when confronting them.

A notable exception to this was at the zoo at which Ben worked. It was clear from my interview with Ben that his position as director of education at the zoo was extremely important in terms of hiring more educators of Color in the education department. Being a Black man in a management position allowed him to have a positive effect on the rest of the department, which is especially notable since the survey responses revealed that efforts around increasing the diversity of management were not common. Efforts to increase staff racial diversity were more commonly discussed by participants, but this suggests that efforts to increase the racial diversity

in management positions in informal science education is vital to changing the culture of these organizations.

Shifting Towards a Cooperative Logic

ISErs generally do not have a lot of knowledge about the communities that they are working with, which can lead to incorrect assumptions, the inability to empathize and relate with students and their families, and a disconnect between them and their site and the people they claim to want to work with. Interview participant Ben discussed how he felt that knowledge of local community or communities is vital for informal science educators who often see themselves as separate from, or providing for instead of part of the community. We see that in the language that informal science educators often use, when they say that they are *serving* the community instead of *working with* the community.

This echoes research that suggests that informal institutions view their relationship with community in one of two ways - client logic or cooperative logic (Feinstein and Meshoulam, 2014). Client logic is when they view themselves as serving the needs of a community that is separate from them and cooperative logic is where they see themselves as part of and working with a community. Client logic is more common and leads to a focus on access and accessibility as, once again, ISErs see their programming as providing something for the community that they are lacking. Efforts around equity, therefore, would likely focus on improving the ability for the community to access their programming and the information or experiences they are providing. A shift toward cooperative logic, or becoming part of and working with communities, is not just a shift in positionality, but a shift in how ISErs might view equity and may come to a better understanding of their community. In addition, I argue shifting toward cooperative logic could be a move toward a framework Rightful Presence (Calabrese Barton and Tan, 2020).

I view these two frameworks (Feinstein and Meshoulam's client logic and cooperative logic and Calabrese Barton and Tan's rightful presence) as different ways an institution might view themselves in relationship to their community and they reflect a difference in commitment and responsiveness of the institution in regards to community. In Figure 3, I show how an informal science center engaging in frameworks of client logic, cooperative logic, and rightful presence view their work with or alongside community members. This figure is a simplification as the frameworks are not necessarily on a linear scale of commitment and responsiveness, but instead shows how the institutions' commitments to community might change if their framing moved toward rightful presence.

I argue here for a movement toward cooperative logic because based on my findings in this paper and prior research, it seems that most informal science educators and their institutions use a client logic framing. Rightful presence as a framework might give the field an idea of an ideal framing in terms of social justice, however based on my discussions with educators and their lack of knowledge about equity, they may not be equipped to move toward this yet. Shifting their framing toward a cooperative logic through professional development opportunities and engagement with community might be a first step toward an ultimate goal of engaging in rightful presence.

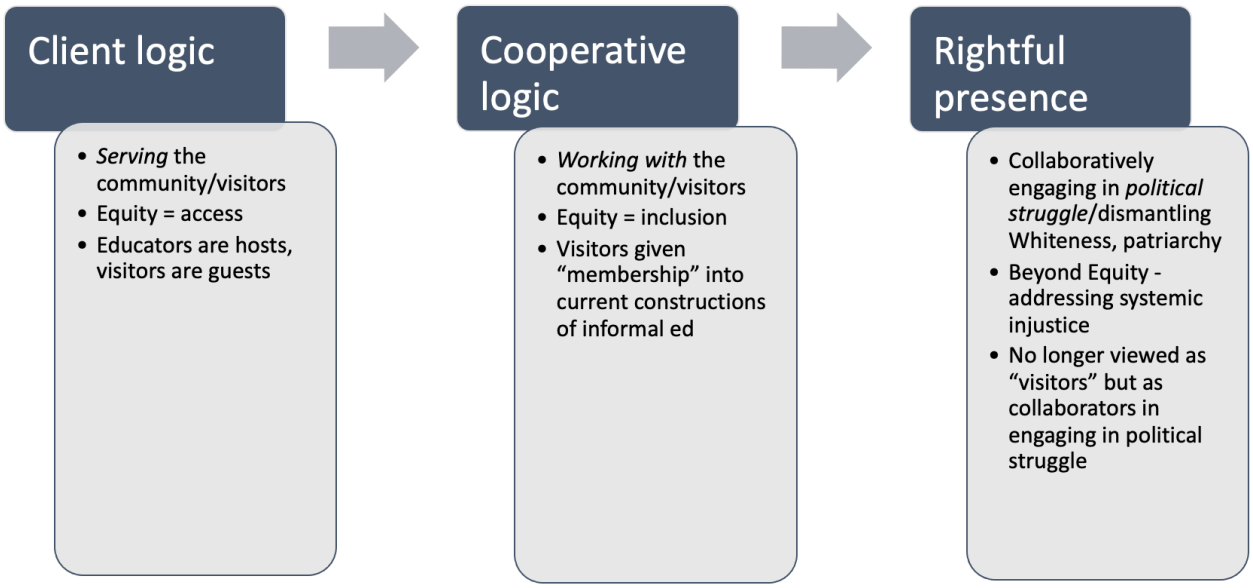

Figure 3. How the frameworks of client logic, cooperative logic (Feinstein and Meshoulam, 2014), and rightful presence (Calabrese Barton and Tan, 2020) reflect the relationships between institution and community and their conceptions of equity.

Conclusion

There are some clear conclusions we can draw from the perspectives and experiences of informal science educators on DEI. First, they care deeply about their work while at the same time they recognize the challenges around DEI that their organizations and the field face. However, because of lack of education around and understanding of DEI, support from their organization, the politicized nature of DEI in the United States, and a culture that positions them as separate from the communities of their participants, the efforts that they are able to engage in are often focused on removing barriers to access instead of engaging in consequential systemic change.

Providing opportunities for further learning and substantial discussions around race, racism, and identity are essential for ISErs who most often do not have opportunities for this type

of education through teacher preparation programs or outside of their work. These learning opportunities need to be encouraged both through a culture of support as well as financial incentives. The field also needs to focus on increasing racial diversity not only of informal educators themselves, but of upper management and leadership positions in informal institutions. Finally, we need a culture shift toward a cooperative logic instead of a client logic (Feinstein and Meshoulam, 2014) by encouraging ISErs to talk to community members, be engaged in community, and even live in communities that they work with if possible. This of course is challenging, especially in informal settings that work with participants from multiple different areas or whose sites might be in locations that are far away from the communities that participants come from.

DISCUSSION

This dissertation has aimed to address some problems of practice in partnerships between informal and formal science education using CHAT as well as issues of DEI in informal science education. Another goal was to give a voice to informal science educators whose perspectives within the science learning ecosystem are often missing from research on the field of ISE, which more frequently focuses on the outcomes for participants. Below I will discuss three broad implications for the field and then some of the limitations of the study.

Implications

In addition to the implications discussed in each individual paper, these manuscripts together have some overlapping implications for the field of science education as well as the smaller field of informal science education. The fields both face some big challenges, particularly around equity and social justice. In addition, the NGSS have set some ambitious goals for science learning, which informal science education could play a role in if productive partnerships are formed. In this section I will discuss three implications of my dissertation work for the field of informal science education and beyond.

Implication 1: CHAT use in ISE

Informal science education as a research field is relatively small, particularly in the United States, however it is a large, interdisciplinary, and multifaceted field in reality. Informal science institutions rely on community partners for visitation, funding, marketing, volunteers, and more. Evaluation research that focuses on youth outcomes of an informal educational experience, though useful for the individual program's growth, is often not generalizable to the broad and varied field. In this dissertation, I have made an argument for the use of CHAT, particularly in the creation and analysis of partnerships between ISE institutions and schools as I

showed in the case study of White Oaks Parks and Morrison Academy. However, CHAT could also be useful to improve other types of partnerships that ISE institutions frequently rely on.

Plakitski (2013) suggested CHAT as a framework for informal science education as well, however its use in the field since has been minimal. She argued that informal science education may have a place in disrupting the prioritization of Western science that often occurs in the classroom. She stated "science of western civilizations, personal science and indigenous science, can occur simultaneously in a learning community" (p. 2) and that CHAT pushes against positivist paradigms that prioritize Western science. Informal science spaces such as museums and science centers do often incorporate social and cultural experiences and mediating tools for learning science, another aspect of the CHAT framework.

Future work with CHAT and the recommendations for productive partnership I suggested could lead to the development of tools, both for practitioners in their partnership work and for researchers in their analysis work. A model based on CHAT could provide partners with starting points for conversations that are vital to the success of a partnership. As I showed in paper 2, challenges arose for Sam and Jessie when they and their partner teachers were unable to communicate effectively. Continued research with CHAT could both assist in these practical applications in the creation of partnerships with a tool as well as continued theorizing about the potential role informal science education might play in pushing against positivist science paradigms.

Implication 2: Power and CHAT

One thing that CHAT does not always explicitly address, but that showed up in my work with White Oaks Parks and Morrison Academy is the influence of unequal power dynamics between systems or within a system. In this case study, the hierarchical structure of the district as

well as the power dynamics between administrators and teachers showed up when Sam and Jessie tried to gain access to various players in the Morrison Academy activity system. They did not realize at first that the administrators might have different goals and expectations than the teachers, but once Sam started programming within the classroom she quickly felt like she was stepping on toes by coming in with a plan that teachers didn't have a voice in creating. Talking with teachers in the PD program over the summer opened their eyes to some of the dynamics that might be present in schools between teachers and administrators. This gave them a little more understanding of context and a realization of why they might be getting some mixed messages from different stakeholders.

Incorporating this idea of power explicitly into CHAT would help ensure that some of these dynamics are named and negotiated early in the work. CHAT could be used to examine what happens when each system does not have equal power in the work of knotworking, co-configuration, developing goals, and more. In partnership research, this would be particularly important as an unequal partnership that is not mutually beneficial is not really a partnership at all, but one system enacting its goals on the other. This happens frequently in research on informal programming with school groups (i.e. field trips) that are sometimes called partnerships, but are actually school groups attending pre-planned programming. As I learned from the ISErs in Paper 3, most ISErs do not have much contact with teachers prior to programming and are unable to change programming due to particular students' needs or interests. The school or teacher may get to choose to attend the program, but there is no co-configuration happening.

Implication 3: Equity in ISE partnerships

Power also clearly plays a role when thinking about equity in informal science education. Many partnerships created between formal and informal science education have an equity focus. White Oaks Parks' mission statement, for example, included language about "parks for all" and their focus on this particular urban school district was because of an identified problem regarding access. As I learned from work on Paper 3, most ISErs who would be engaging in these types of partnerships that are attempting to address equity in some way do not have a clear understanding of DEI issues and do not feel they have the agency to address equity issues in meaningful ways for a variety of reasons, including feeling a lack of power in their organizations. As this is a goal for many ISE partnerships, it is essential that more opportunities and higher quality opportunities for further education around equity become available to ISErs.

It is also important that the field as a whole works to move past a conception of equity that only addresses access concerns and instead works to interrogate underlying systems and discourses that exclude marginalized communities. This way partnerships that have an equity focus can more meaningfully address inequitable systems and work *with* community partners in true partnership, instead of viewing their work as serving the community. Feinstein and Meshoulam (2014) call these two viewpoints client logic (serving their participants) and cooperative logic (working with their participants). This shift toward a cooperative logic will be difficult, as a client logic is ingrained deeply in a lot of informal institutions. The reason for this is both cultural and historical and, therefore, CHAT might be a useful theory to explore different types of interactions between communities and informal science institutions to see what kinds of work needs to be done in order to engage in cooperative logic. Again, one step toward this work would be increasing the quantity and quality of further educational opportunities around these

issues for ISErs who may not yet have a deep understanding of equity and why this shift is important.

Limitations

The two empirical papers included in this dissertation have some important limitations. As a case study, Paper 2 tells the story of the creation of a partnership from the perspective of two individuals involved. To strengthen this paper both in telling the story of the partnership as well as the connections to Cultural Historical Activity Theory, I would have liked to get the perspectives of teachers and administrators involved in the partnership. Unfortunately, due to time constraints for this particular study as well as a lack of response from administrators, this was not possible. Therefore, I focused on the perspective of the White Oaks Parks interpreters and relied on their interpretation of events. This still enabled me to think about how CHAT might be a useful organizing lens on their real and perceived partnership with Morrison Academy teachers. I also hoped to observe Sam in the classroom, however similar red tape that they encountered as well as lack of response again prevented me from doing so. As a result, I am unable make any claims from observation about how the partnership was addressing or not addressing the partners' goals, so again I relied on and reported on their perceptions of the success of the partnership instead.

Although I got a moderately wide range of survey respondents which I was able to report on in Paper 3, I had about 20 responses that were unusable because the survey participant did not complete over 50% of the questions. I noticed that many were completing up to the same point, where they would need to press a button to go to the next page. I was unsure if this was due to the survey being too long or if participants did not realize there were multiple pages. I added a progress bar to the survey to make it clearer, which did seem to increase completion rates for

participants after that point in time. Having more survey responses would have provided me with more examples and strengthened my arguments. My interview participants were chosen from those who expressed willingness to be interviewed at the end of the survey. I emailed all survey participants who expressed interest, but only about half of those participants responded. I had even fewer who set up a time to be interviewed. In the end, I interviewed all participants who scheduled an interview, but because of the smaller number of volunteers, I was unable to choose interviewees that matched the demographics of ISErs across the state. I had a higher number of interviewees who identified as male as well as a higher number of interviewees who were later career ISErs and in leadership roles in their institutions.

Despite these limitations, this work contributes to the field by investigating aspects of informal science educators' work and experiences that are not often included in science education and teacher education research. Informal educators are professionals who can play a large role in science engagement for both youth and their families. Productive partnerships between schools and informal science institutions may provide a more cohesive science learning ecosystem and promote higher science engagement. In order for this work to be equitable, informal science educators, like classroom teachers, need more opportunities to learn about DEI and social justice issues and the institutions need to prioritize this, requiring a shift in their framing of equity and moving beyond a focus solely on access.

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APPENDIX A: INFORMAL EDUCATOR DEI SURVEY

INFORMED CONSENT

1. EXPLANATION OF THE RESEARCH and WHAT YOU WILL DO

You are being invited to participate in a research study that is part of an NSF DRK-12 grant – Teaching Science Outdoors-Urban Partnerships (TSO-UP). This study seeks to understand the perspectives and experiences of informal science educators (ISErs) in relation to diversity, equity, and inclusion (DEI). Note that we are defining informal science educator quite broadly to include anyone that teaches about science outside of the classroom, with the understanding that many of you might identify as something else (naturalists, nonformal educators, interpreters, outdoor educators, museum educators, etc.).

We hope this survey will inform what kind of ideas ISErs have about DEI, what opportunities for learning they have, and what additional supports would be useful to ISErs. At the end of the survey there will be an option to express interest in further discussion of DEI issues in outdoor/informal education through a focus group and/or interview.

The data for this project will be kept confidential and analyzed only by those associated with the project. Your name, your organization's name, or other identifying information will not be included in any report of the results of this study. Data may be accessed by MSU's Human Research Protection Program (HRPP) and/or released to other researchers involved in the study. Before any work is shared, all personal identifiers will be removed. You must be at least 18 years old to participate in this research.

2. YOUR RIGHT TO PARTICIPATE, SAY NO, OR WITHDRAW

Participation in this research project is completely voluntary. You have the right to say no. You may change your mind at any time and withdraw. You may choose not to answer specific

questions or to stop participating at any time.

3. PRIVACY AND CONFIDENTIALITY

The data for this project will be kept confidential. Only de-identified data (with no names or other information that could identify you) will be shared with partners collaborating in this research. The results of this study may be published or presented at professional meetings, but the identities of all research participants will remain anonymous.

4. CONTACT INFORMATION FOR QUESTIONS AND CONCERNS

If you have concerns or questions about this study, such as scientific issues, how to participate in any part of it, or to report an injury, please contact the researcher (Contact information provided)

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the [University's Human Research Protection Program contact information].

By continuing this survey you indicate that you are providing your consent to participate in this research. If you do not wish to participate, click on the "I do not wish to participate" button" and you will exit the survey.

- I consent to participate (1)
- I do not wish to participate (2)

EDUCATOR IDENTITY

Q1 I identify as a(n) (check all that apply)

- Informal Science Educator (1)
- Nonformal Science Educator (2)

- Naturalist (3)
- Interpreter (4)
- Outdoor Educator (5)
- Interpreter (6)
- Museum educator (7)
- Other (please specify) (8)

Q2 Who are the participants that you work with? (check all that apply)

- PreK-12 student groups (1)
- Families (2)
- General public (3)
- Teachers (4)
- Scientists (5)
- Other (please specify) (6)

Q3 For any part of your work, do you work with PreK-12 public schools/students from urban areas?

- Yes (1)
- Maybe (2)
- No (3)

Q4 Do you work with any particular urban schools, school districts, or other k-12 programs? (if you do not work with students from urban areas please put N/A)

DEMOGRAPHICS

We understand and respect the diversity of cultural and social aspects of identity. For the purposes of this study, we would like to know more about aspects of your identity.

Q5 Gender: How do you identify?

- Female (1)
- Male (2)
- Non-binary (3)
- Prefer not to say (4)
- Prefer to self identify (5)

Q6 Do you identify as...

- Hispanic (1)
- Latina/o/x (2)
- None of the above (3)

Q7 Race: select any of the following categories you identify with

- American Indian or Alaska Native (you may enter your tribal affiliation in the associated text box) (1)

  _____

- Asian (2)
- Black or African American (3)
- Native Hawaiian or Pacific Islander (4)
- White (5)
- Other (you may specify if you want) (6)

YOUR PARTICIPANTS

We recognize that informal educators work with a large variety of audiences. We would like to learn a little more about the participants you work with. If you do not work with any of these specific audiences, simply write N/A.

Q8 How would you describe the demographics (including race, gender, ethnicity, ability, etc.) of your PreK-12 student and teacher participants?

Q9 How would you describe the demographics (including race, gender, ethnicity, ability, etc.) of your family/public participants?

Q10 How would you describe the demographics (including race, gender, ethnicity, ability, etc.) of your educator participants?

Q11 How would you describe the demographics (including race, gender, ethnicity, ability, etc.) of the staff at your organization/site?

DEI

We are hoping to gather some information about how you and/or your organization views Diversity, Equity, and Inclusion. For the purposes of this survey, we are defining diversity as people from a range of different socioeconomic, racial, and ethnic backgrounds and of different genders, sexual orientations, and abilities.

Q12 My organization has participation from a diverse audience

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Q13 My organization has a diverse staff

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)

- Somewhat disagree (4)
- Strongly disagree (5)

Q14 My organization encourages discussions around issues of diversity, equity, and inclusion.

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Q15 I have had opportunities for professional development around diversity, equity, and inclusion.

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Q16 Would you like to elaborate on any of the above questions?

ORGANIZATIONAL EFFORTS

In this section, we are hoping to learn about the efforts and discussions your organization has implemented around issues related to diversity, equity, and inclusion.

Q17 Describe the conversations your organization has had with staff around diversity, equity, and inclusion, if any.

Q18 Describe any efforts to increase diversity, equity and inclusion that you or your organization have implemented.

Q19 Which of the following is being actively addressed at your site/organization? (check all that apply)

- Access to site (including transportation and entry costs) (1)
- Programming that reflects the cultures of participants (2)
- Physical accessibility (3)
- Diversity of staff (4)
- Diversity of management (5)
- Making sure that program participants feel like they belong at our site/organization (6)
- DEI training for staff (7)
- Inclusive signage (including language and cultural inclusivity) (8)
- Other important DEI efforts (please describe) (9)

Q20 Which TWO of the items in the previous question are most important to you in your work and why?

Q21 What more could be done at your site to address the two items you identified in the previous question as most important to you?

Q22 What barriers or challenges, if any, have you experienced in implementing any DEI initiatives at your site?

YOUR WORK WITH PARTICIPANTS

For the last couple questions, we are hoping to understand a bit about your personal interactions with the participants at your program, in particular those that have historically have been marginalized in educational settings.

Q23 Describe how you get to know the PreK-12 students who visit your site. For example, how do you welcome students? What do you know about your students before they arrive? How do you get to know them while they are there? (put N/A if you do not work with these audiences)

Q24 Partcipants at my program feel like they are welcome in the space

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Q25 I am able to be flexible in my programming to adjust to participant interests

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Thank you! Thank you so much for participating in this survey! If you are interested in being interviewed one-on-one for this project, please include your email address here.

APPENDIX B: INFORMAL EDUCATOR DEI INTERVIEW PROTOCOL

1. Tell me about your journey into the informal science education field
    a. How long have you been in the informal ed field?
2. What do you love about your job? What is most challenging about your job?
3. Describe the programming that you do with public school groups?
    a. Do you have any control over the design of this programming? Is it a set program? Is there flexibility within the programming?
4. What are the racial demographics of staff at your site and what are the racial demographics of public school group visitors?
5. When you are working with students who have a different racial identity than you, in what ways, if any, do you feel that difference affects your interactions with those students?
6. Describe efforts your organization has made (look these up from survey).
7. Elaborate on the barriers that you noted to DEI efforts of your organization.
8. What kinds of efforts would you like to see your organization make if there were no barriers? What would it look like? If barriers did not exist, what would be most important to you to address?
    a. Have you shared any of these ideas and how might that be taken up?
9. [note mentions of DEI related training] - could you elaborate on what those trainings are like, what they are focused on, etc.?