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Nature and Transdisciplinarity: Youths' Perceptions of the Impacts of an Afterschool Program on Their Relationship with Nature and Environmental Problem-Solving

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Nature and Transdisciplinarity: Youths' Perceptions of the Impacts of an Afterschool Program on Their Relationship with Nature and Environmental Problem-Solving

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Education

by

Stacey Marie Vigallon

2021

ABSTRACT OF THE DISSERTATION

Nature and Transdisciplinarity:

Youths' Perceptions of the Impacts of an Afterschool Program on Their Relationship with Nature and Environmental Problem-Solving

by

Stacey Marie Vigallon

Doctor of Education

University of California, Los Angeles, 2021

Professor William A. Sandoval, Co-Chair

Professor Kristen Lee Rohanna, Co-Chair

Effectively addressing complex, real-world problems like climate change requires expertise from and collaboration across multiple disciplines. It will be essential to provide educational opportunities that help students from all backgrounds build identities as creative problem-solvers. Informal education programs that combine transdisciplinary learning with outdoor, nature-based components may be uniquely positioned to foster problem-solving by students because they combine an array of experiential and reflective practices in contexts distinct from school and home. This exploratory sequential mixed methods case study examined a Los Angeles after-school program for high school students. The study identified key program elements and investigated how those elements influence participants' relationship to nature and sense of empowerment to address environmental problems. Additionally, the study described

how participants act as environmental problem-solvers in their own lives following program participation. Findings suggest that numerous key elements work concurrently within the focal program that influence participants' connection to nature, the development of their problem-solver skills, and their sense of empowerment. Findings also indicate that participants are engaged in a range of nature practices and do act as environmental problem-solvers in their own lives. The study finds parallels in the literature, but also offers an asset-based perspective on urban students' relationship to nature and stewardship.

The dissertation of Stacey Marie Vigallon is approved.

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2021

DEDICATION PAGE

To the program alumni who participated in this study. For over a decade, you have been responsible for shaping my thinking - and feeling - about nature, community, and how the two interact. I admire your willingness to try something new, and I am indebted to you for helping to build an ever-evolving program in an attempt to make the world a better place for humans and non-humans. This dissertation would not have been possible without your thoughtful and candid interview participation. You were so generous with your time while also trying to survive a pandemic. This study draws heavily, as Barry Lopez would say, “on the courtesy and genius of the community.”

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Chapter One: Problem Statement

Introduction

Effectively addressing critical, real-world problems requires expertise from and collaboration across multiple disciplines because the complexity, interdependence, and unpredictability that characterizes real-world problems overwhelm any single discipline (Klein, 2004). A demand exists for education approaches that cultivate a workforce with a facility for collaborative thinking and an openness to alternative solutions (Hammer & Soderqvist, 2001; Lang et al., 2012; Quigley, Jamil, & Herro, 2017). However, opportunities for students to develop and apply literacy, numeracy, and critical-thinking skills to contexts outside the classroom are the exception rather than the rule (Orr, 1992). Inequities further compound this existing limitation, with low-income students of color facing barriers that prevent them from accessing an array of educational and recreational opportunities that their peers in higher socioeconomic strata do not face (Charland, 2010; National Science Foundation, 2017; Louv, 2005). These inequities within our education systems coincide and interact with cultural phenomena that further hinder people from understanding the urgency, complexity, and scale of real-world crises. An increasing fear of nature (Louv, 2005), the disappearance of language to describe the natural world (Macfarlane, 2015), and the erosion of skills as fundamental as way-finding (McKinlay, 2016) exemplify blockades to effective crisis awareness and mitigation.

Despite these challenges, youth are stepping into the role of problem-solvers and community stewards. Climate activist Greta Thunberg, a teen, helped initiate an international global warming awareness movement (Thunberg, 2018) and addressed the United Nations' Climate Action Summit in September 2019 (Chappell, 2019). Inventor William Kamkwamba of Malawi, at age fourteen, designed and built a windmill to provide electricity for his family, using

a book from his local library and discarded materials (Kamkwamba & Mealer, 2009). And, in December of 2018, a group of teens in Raqqua, Syria created their own school within war zone conditions (Sherlock, Al-Arian, & Sadoun, 2018). Educational opportunities that help students from all backgrounds build identities as creative problem-solvers may be an essential and sustainable way to address the global crises we face. In particular, informal education programs that combine transdisciplinary learning with outdoor, nature-based components might have the potential to foster problem-solving by students because they combine an array of experiential and reflective practices.

Background

I will examine the nexus of transdisciplinary learning, informal education, and outdoor or nature-based education as a way to foster students' connection to nature and students' sense of empowerment to address environmental problems. To better understand the relationship among these elements, I briefly describe transdisciplinary learning and the role of the arts in inquiry; student identity formation as it relates to learning, inequities that also shape identity, and students as problem-solvers; and the role that informal outdoor or nature-based programs may play in learning and identity formation.

Transdisciplinary Learning and the Role of the Arts in Inquiry

Well-rounded transdisciplinary approaches keep students at the center of the learning practice by engaging them in complex cognitive processes beyond just skill acquisition (Bequette & Bequette, 2012; Connor et al., 2015). In the K-12 setting, transdisciplinary learning is more often referred to as STEAM – Science, Technology, Engineering, Arts, and Math. Transdisciplinarity aims to not just integrate multiple disciplines, but to create perspectives and problem-solving techniques that transcend any single discipline. Transdsciplinarity is essentially a *whole is*

greater than the sum of its parts approach to collaboration among fields of knowledge (Hammer & Soderqvist, 2001; Herro & Quigley, 2017; Stokols, Misra, Moser, Hall, & Taylor, 2008; Vanasupa, McCormick, Stefanco, Herter, & McDonald, 2011). Opportunities that allow students to bring to the science classroom their lived experience and their skills associated with non-science activities, and opportunities for open-ended creativity have been effective transdisciplinary practices at the undergraduate (Bozzone and Doyle, 2017), middle school (Shanahan & Nieswandt, 2009) and high school levels (Shaw, Fields & Kafai, 2019).

Throughout human history, human survival has been predicated on an understanding of the natural world, and nature has been foundational to the development of culture and the arts. Thus, the integration of the arts and humanities into contemporary STEM learning to create STEAM, offers a more wholistic approach to understanding the world. STEAM requires participants to engage aesthetic and social approaches that go beyond purely technical solutions to a problem. The arts can serve as an entry point and complement to STEM topics, especially when the goals are increased engagement and achievement in STEM (Kim, Ko, Han, & Hong, 2014; Root-Bernstein et al., 2008; Yakman & Lee, 2012). Giving equal weight to aesthetic inquiry in STEAM-based programs lends itself well to addressing the complexity of real-world problems (Bequette & Bequette, 2012) and can allow for co-existing viewpoints and new lines of inquiry when viewpoints are in conflict (Vanasupa et al., 2011). Aesthetic inquiry widens the possibility of novel and unexpected solutions with broader moral implications (Campbell & Dalton, 2019; Guyotte et al., 2014). Within the scientific community over the past decade, there has been a push to embrace aspects of narrative storytelling when communicating with the general public and when publishing in peer-review journals (Atkins, 2016; Krzywinski & Cairo, 2013). Looking beyond the inquiry process itself, research demonstrates that engagement in the

arts may confer emotional and cognitive benefits to participants (Abbott, Shanahan, & Neufeld (2013; Kaimal & Muniz, 2016; Corkhill, Hemmings, Maddock & Riley, 2014; Andrade, 2010)

Student Identity Formation, Inequities, and Students as Problem-Solvers

Little empirical knowledge currently exists to describe and quantify the impact that STEAM-based programs have on student learning. Furthermore, we know little about the type of educator support, competence levels, and school culture required for educators to effectively implement STEAM programs (Herro & Quigley, 2017; Quigley, Jamil, & Herro, 2017; Robelen, 2011). However, research on student and teacher identity across multiple disciplines provides glimpses into the advantages of and challenges faced by STEAM-based programs. Identity adapts and changes with context along multiple dimensions, and identity may serve as "the fulcrum that connects cognitive and socioemotional development" (Lee, 2017, p.518).

Though identity and learning are strongly tied (Bell, Van Horne & Haugan Cheng, 2017), the identities youth bring to the classroom are often dismissed, especially in STEM where rationality, objectivity, and political neutrality are prized traits (Carlone, 2017; Pulkki, Dahlin & Veli-Matti, 2017). Additionally, access to opportunities that develop disciplinary identities is not equitable among all students. This reality has powerful ramifications for the students themselves and for the future of environmental stewardship. Developing a positive attachment to the natural environment is a prerequisite to developing the kind of problem-solver who can recognize and engage in complex environmental issues. Throughout the U.S., non-white communities experience higher than average human modification to natural landscapes, an indicator of habitat loss and fragmentation (Landau et al., 2020). People from communities of color are less likely to participate in outdoor recreation (Lee et al, 2001), visit the national park system (Scott & Lee, 2018), and are also less likely to engage in informal STEM learning opportunities at museums

(Dawson, 2018). Minority groups also face challenges in accessing STEM academic and career pathways (National Science Foundation, 2017) and visual arts pathways (Charland, 2010). When considered holistically, it may be that these barriers to access result in low-income students of color having a very different, and potentially diminished, sense of their role in addressing environmental crises when compared to their higher-SES peers.

Given the limitations and inequities within our education system and beyond, how can students develop identities that include being problem-solvers? The literature addressing the concept of students as problem-solvers spans K-12 through the graduate education level, embraces transdisciplinary learning, and overlaps with research on leadership. Across all grade levels, programs that incorporated components of community connection, collaboration, communication, and addressing real-world issues were found to increase student problem-solving skills (Bush et al, 2019; Cantor et al, 2015; Moslemi et al, 2009). Interpersonal skills were viewed as equal in importance to subject knowledge. At the K-12 level, and for teens in particular, programs that used the five tenets of Positive Youth Development, competence, confidence, character, connection, and caring, demonstrated a positive impact on student attitudes towards civic endeavors. And, programs that offered students "real world" experiences contributed positively to students' development as leaders (Bush et al, 2019). For K-12 arts-based problem-solving, students were encouraged to use synectic thinking - the process of conceptually linking disparate elements - and to generate multiple approaches to addressing a problem (Kulinski, 2018). At the undergraduate and graduate level, an emphasis on deeply complex, nearly intractable real-world problems, known as "wicked problems", pushed students to develop a range of competencies: working collaboratively across disciplines, improving their

resilience to setbacks, engaging in more than one research methodology, and participating in a community of practice within and outside academia (Cantor et al, 2015; Moslemi et al, 2009).

The Role that Informal Outdoor or Nature-based Programs May Play in Learning and Identity Formation

Shifting the lens away from formal education settings and instead focusing on informal education settings provides an opportunity to examine a wider array of approaches to transdisciplinary learning. Museums, parks, non-profits, public libraries, and other non-school entities devote considerable funding and staff time to the development and implementation of educational programming, and their philosophical underpinnings and overall approach to education may differ widely from one another and from those in formal education settings. For example, science museums tend to make learning central to their mission, while art museums may situate learning among several other objectives, decisions that in turn influence educational program content and pedagogy (Luke & Knutson, 2010). Further narrowing the scope of examination, informal education programs that incorporate aspects of nature or the outdoors tap into behaviors, skills, and cultural beliefs that receive less emphasis in indoor settings. "The human lived body is not merely a curiosity of abstract philosophical reasoning, but a concrete site for EE [Environmental Education] (Pulkki, Dahlin & Veli-Matti, 2017, p.218). Access to and time spent in natural spaces have a positive impact on physical and mental health (Bowler et al, 2010; Corraliza, 2012; Louv, 2005). In addition, a sense of connectedness to the natural world is malleable, influenced by factors such as personal belief systems, experiences with nature (Shultz & Tabanico, 2007), and age (Hughes et al, 2019).

Outdoor learning opportunities can serve as a safe entry point to nature and a link to academic achievement and long-term environmental stewardship. Effective environmental

education programs are those that allow students to be active participants in real research and engage students over a prolonged period of time (Adams & Savahl, 2017), and many educators see the value in outdoor learning experiences as a way to provide students with fun, authentic, experiential learning (Waite, 2011). Outdoor, place-based opportunities can help students develop science identities (DeFelice et al, 2014), develop positive social relationships with peers, mentors, and family (Fifolt et al, 2018), and foster an interest in future involvement in stewardship activities (DuBois et al, 2018). Key factors that create positive attitudes towards nature and environmental stewardship include positive experiences in nature and role models that engage youth in nature-based activities (Chawla, 2007; Chawla and Derr, 2012; Sivek, 2002), both of which can be encompassed in outdoor learning programs. Thus, transdisciplinary learning opportunities that are nature- and place-based may offer students the opportunity to explore other ways of knowing, engaging in reflective and contemplative learning practices that call into question dominant epistemologies and identities (Deringer, 2017; Lee, 2017).

Study Overview

Student identity and its link to learning, particularly in STEM, is currently an active area of research (Bell, Van Horne & Haugan Cheng, 2017; Van Horne & Bell, 2017). However, specifically examining students' "problem-solver" identity at the nexus of transdisciplinary learning, informal education, and the outdoors would be a unique line of inquiry. Informal education programs operate in a context that is considerably less prescribed and regulated than formal education settings, resulting in programming that varies widely in scope, timeframe, location, philosophy, and learning objectives. The purpose of my study was to find out how, if at all, an informal transdisciplinary outdoor education program fostered students' connection to

nature and students' sense of empowerment to address environmental problems. The following research questions guided my study:

1. What are the key program elements that influence students' relationship to nature and sense of empowerment to address environmental problems?
2. How do the key program elements influence students' relationship to nature and sense of empowerment to address environmental problems?
3. Following program participation, in what ways do students (a) view themselves in relation to nature and (b) act as environmental problem-solvers in their own lives?

Research Design

I used an exploratory sequential mixed methods case study design (Creswell & Plano Clark, 2018) to examine one informal education program that incorporates transdisciplinary learning as well as aspects of nature and outdoor learning, to better understand how that program may foster problem-solving by students. Methods included interviews and a survey, and this approach employed in-depth description and analysis of the program. The case study approach allowed me to examine program characteristics in-depth, center study participant experiences, and attempt to uncover how program elements influenced problem-solving.

Study Population

I examined one program set in urban Los Angeles, managed by a local environmental non-profit organization. To protect the anonymity of study participants, the focal program is referred to with the pseudonym, Outside After-School Program (OASP). Established in 2008 and based at a local park, the focal program incorporates transdisciplinary learning as well as aspects of nature and outdoor learning. Field biology and social science methods, reflective and creative writing, observational drawing, graphic design, hand craft, and public speaking are all regularly

incorporated into focal program activities. Community leadership opportunities, projects focused on local environmental issues, and collaborations with partners at the regional level are also features of the program. Typically serving 30-40 high school students each school year, the program meets 1-3 days a week after school and weekends throughout the school year. Students earn stipends or community service hours for their participation and can re-apply to the program each year. The program aims to engage students relatively local to the park and informally remains in contact with program alumni once they graduate high school. I engaged individuals from all strata of the program: program staff members who were also program alumni, non-staff program alumni, and current students who have been program participants for at least one school year.

Significance

This study offers insight into approaches that position students to see themselves as creative individuals capable of employing multiple inquiry skills to solve real environmental problems. Results are relevant to other informal education programs and could be adapted to serve formal education settings as well. I plan to share the findings of this study through multiple venues, including local and national conferences, such as the California STEAM Symposium, the annual Ecological Society of America conference, and the annual North American Association for Environmental Education conference. I will also pursue publication in relevant journals, such as *Journal of Experiential Education*, *Journal of Environmental Education, Journal of Natural History Education and Experience,* and *Frontiers in Ecology and the Environment*.

Chapter Two: Review of the Literature

Overview

Real-world problems are complex, dynamic, and interdependent, necessitating collaboration across disciplines and ways of knowing (Klein, 2004). In the field of conservation science, some researchers have urged a transdisciplinary, socially engaged approach to conservation science education in higher education contexts, an approach that includes training in problem-solving skills for students in environmental studies departments (Toomey, Knight, & Barlow, 2017). However, limitations and inequities within our education systems coincide and interact with cultural phenomena, hindering people from participating in the problem-solving process and from even understanding the scale and urgency of real-world crises. Educational opportunities that help students from all backgrounds build identities as creative problem-solvers may be a vital way to address the global crises we face. I examined the nexus of transdisciplinary learning, informal education, and nature-based education as a way to foster creative problem-solving by students and students' sense of empowerment to address problems.

To better understand the relationship among these elements, in this chapter I first describe educational supports that may help students become problem-solvers. I next discuss transdisciplinary learning, the role of the arts in inquiry and as a science collaborator, and the role that informal outdoor or nature-based programs play in student learning. Access to these learning opportunities is then framed as an equity issue, and I conclude with a discussion of informal learning environments as spaces for transdisciplinary learning.

What Does It Mean to Be a Creative Problem-Solver?

When disaster strikes, "most people are altruistic, urgently engaged in caring for themselves and those around them, strangers and neighbors as well as friends and loved ones.

The image of the selfish, panicky, or regressively savage human being in times of disaster has little truth to it" (Solnit, 2010, p.2). Disasters, states Solnit, "demonstrate how deeply most of us desire connection, participation, altruism, and purposefulness" (p.305). Being a creative problem-solver is rooted in these human desires. In my study, I define "problem-solvers" as having the following characteristics: they identify and articulate a problem in their community; possess the motivation to take concrete steps to attempt to address the problem; understand the importance of working collaboratively and know when to seek the expertise of others in areas in which they have limited knowledge; employ imagination and creativity in developing solutions to the problem; and are resilient to the setbacks inevitable in addressing real-world problems. Instances abound of creative problem-solvers at work in the world. In Bolivia, cardiologist Franz Freudenthal collaborated with indigenous Aymara artisans to create a life-saving device reliant on both cutting edge medical technology and traditional weaving technology (de los Reyes, 2015). Community responses to the Covid-19 crisis highlighted in the news media provide excellent recent examples as well, ranging from a Nigerian tech entrepreneur who created an app to help local churches and community members more safely connect virtually and through reservations, to an architect in India who designed recyclable cardboard beds for Covid-19 wards that could be made quickly and cheaply at a local paper factory (NPR Staff, 2020).

Artist David Byrne's most recent endeavor serves as both an example and promotion of creative problem-solving. Initiated as a response to the sense of despair many feel when confronted with the mainstream news cycle, Byrne's non-profit online editorial project *Reasons to Be Cheerful* focuses exclusively on the solutions emerging from work by individuals, organizations, and institutions world-wide. The philosophy of creative problem-solving is

exemplified in the work of Alaskan artist Allison Akootchook Warden, an Iñupiaq tribal member. Her artist statement succinctly describes her problem-solving approach:

> My role as an artist is that of a community healer, one that provides inclusive environments for all people to decolonize and to process the impacts of the changing climate and also the political climate. I see museum spaces and art galleries as quintessential spaces from which to continue the healing work of my bloodline. In 2018, my tools are installation art, social practice techniques, sculpture, visual art, performance art, sound art, music, creative writing and video installation. I see all genres of art as possible healing methodologies, activated through the lens of my Ancestors. It is important that I have freedom in my creative practice to connect all genres of art towards my proposed hypothoses [sic] and the possible solution to the community "sore spot". (Akootchook Warden, n.d.)

Research by Birmingham & Calabrese (2014) helps to frame the idea of creative problem-solving within the context of my study's themes of transdisciplinary learning, informal education, and nature. In their critical ethnography of an afterschool science program, Birmingham & Calabrese describe problem-solving by youth through "educated action in science" (p.287). Youth, age 7-17, from underrepresented communities in urban Michigan participated in science learning through GET City, a program hosted by the local Boys & Girls Club. Employing place-based and problem-based learning strategies, the program supported youths' inquiry into local energy and environmental issues, and then put youth in the meaningful role of being educators by supporting the production of multimedia products that summarize and disseminate the results of the inquiry. In addition to the multimedia products, the youth, with the support of program staff, designed and implemented a "green" community carnival that initiated

a dialogue with their community about energy issues. “The youth in this study show the power of situating investigations through place as well as providing opportunities for youth to leverage multiple areas of expertise to take educated action on socioscientific issues” (p.310).

The work by Birmingham & Calabrese is highly relevant to the goals of my study, in that the authors address the process by which students became problem-solvers. The section that follows describes how approaches to learning may shape students’ development as problem-solvers.

Supporting Students in Becoming Problem-Solvers

The problem-solver definition employed in this study encompasses cognitive and socio-emotional qualities that, much like identity, are dynamic and context-dependent. The body of literature addressing the concept of students as problem-solvers spans K-12 through the graduate education level, embraces transdisciplinary learning, and overlaps with research on leadership development.

Experiential learning and the psychological phenomena specific to problem-solving tasks serve as an important starting point to conceptualize the student as problem-solver. Especially instructive are Kolb’s (1984) definition of learning – “the process whereby knowledge is created through the transformation of experience” (p.38) – and Dewey’s emphasis on thinking as “the intentional endeavor to discover specific connections between something which we do and the consequences which result, so that the two become continuous” (Dewey, 2004, p.140). Additionally, the idea that the “senses are avenues of knowledge” (Dewey, 2004, p.136) has strong ties to students’ lived experience and practices like art-making, mindfulness, and environmental education that will be discussed later in this chapter. Experiential learning, then, might be viewed as a life-long, iterative process of interacting with the real world and adjusting

accordingly, such that student learning is something that occurs well beyond confines of the formal education context. Problem-solving has also been viewed as an iterative or cyclical process, requiring knowledge on the part of the participant, but also tapping into issues of self-efficacy, motivation, resourcefulness, and self-regulation. Whether they are experts or novices, successful problem-solvers learn from repeated failures and concurrently maintain positive motivational self-beliefs until a solution is achieved (Zimmerman & Campillo, 2003). This concept has serious ramifications for pedagogy, underscoring the importance of creating learning environments that support cognitive and social-emotional needs of students.

In terms of student learning, identity may serve as "the fulcrum that connects cognitive and socioemotional development" (Lee, 2017, p.518). Despite being a rich topic of research, there is no single definition for identity (Clayton & Opotow, 2003). For the purpose of my study, I define *identity* as a concept of self that is a dynamic and "multidimensional cognitive structure," incorporating both personal and social aspects and reflecting what seems possible for oneself within a given social and cultural context (Oyserman & Destin, 2010, p. 1004). Individuals have multiple, and sometimes competing, identities at the same time, and identities are contextually adaptive (Lee, 2017; Oyserman & Destin, 2010; Riggs Stapleton, 2015). Successfully centering student interests in instruction requires a better understanding of how interests are linked to motivation. Self-directed engagement, and persistent engagement in particular, is a nuanced, dynamic process incorporating psychological, physical, material, cultural, communal, and institutional aspects (Azevedo, 2011).

Aspects of social practice theory have also been used to create models for better understanding the interplay between interest, identity, and learning. A sense of belonging is foundational to motivation, achievement, and effort (Faircloth and Hamm, 2005; Goodenow,

1993), and spaces where the adults in charge make students feel welcome are linked to a higher sense of belonging (Akiva et al. 2013). Though identity and learning are strongly tied (Bell, Van Horne & Haugan Cheng, 2017), the identities youth bring to the classroom are often dismissed, especially in STEM where rationality, objectivity, and political neutrality are prized traits (Carlone, 2017; Pulkki, Dahlin & Veli-Matti, 2017). When students are able to learn about specific professionals doing science disciplinary work and the broader social implications of that work, they may be able to connect themselves and their daily lives to science practice (Van Horne & Bell, 2017). Factors that have been found to influence declaration of STEM majors include not only high school math achievement and access to math and science classes, but also student beliefs in their own academic ability (Wang, 2013).

Problem- and Project-Based Learning (both frequently referred to as PBL) serve as pedagogical approaches that seek to incorporate cognitive and social aspects of learning, and they have been employed in K-12 and higher education contexts. Both approaches support Dewey's (2004) notions that "all thinking is research" (p.142) and that the "twilight zone" (p.143) between knowledge and ignorance is the inquiry process. Problem-based learning originated in a medical school context in the 1960s and 70s, where instructors provided a relevant focal problem and guidance, but student learning was primarily self-directed and collaborative (Schmidt et al, 2009). In this setting, Schmidt et al found that the approach resulted in increased interpersonal skills, better practical medical skills, and lower drop-out rates compared to students in programs that used conventional approaches to learning. Similarly, Tiwari et al (2006) found that undergraduate nursing students in a problem-based learning program not only reported the experience to be enjoyable and fulfilling, but also scored

significantly higher on a critical thinking assessment during and two years after the program compared to students in a lecture-based program.

The Problem-Based Learning approach has since been adopted in K-16 settings, and its primary components are well summarized by Kumar & Natarajan (2007): a problem or question initiates the process; multiple resources and points of view are required to address the problem; the process is collaborative and iterative, necessitating critical and creative thinking and reflection; and the teacher takes on more of a facilitator or coach role. At the undergraduate and graduate level, the approach has been linked to students' belief that their learning was enhanced (Dochy et al, 2005; Mossuto, 2009) and that they gained interpersonal and teamwork skills (Mossuto, 2009). In a higher education context, an emphasis on deeply complex, nearly intractable real-world problems, known as "wicked problems", pushed students to develop a range of competencies: working collaboratively across disciplines, improving their resilience to setbacks, engaging in more than one research methodology, and participating in a community of practice within and outside academia (Cantor et al, 2015; Moslemi et al, 2009). Within a K-12 setting, problem-based learning has similarly been linked to students' self-reported increase in interpersonal skills and a sense of ownership over the learning process (Ferreira & Trudel, 2012) and to self-reported increase in student confidence and knowledge (Kulinski, 2018). Wong and Day (2009), in their study of Hong Kong secondary students, suggest that problem-based learning may have longer term effects, demonstrating measurably higher scores in science comprehension and science knowledge application in a delayed post-test compared to students in a lecture-based learning program.

In the K-12 context, there appears to be overlap between problem- and project-based learning, and Barron et al (1998) suggest that when problems are used as scaffolds for projects

student learning is increased. Similar to problem-based learning, project-based learning is typically collaborative and cross-curricular, and also lends itself well to the inclusion of digital technology (Han et al, 2015). It embodies Dewey's notion that educators "should know how to utilize the surroundings, physical and social, that exist so as to extract from them all that they have to contribute to building up experiences that are worth while" (Dewey, 1938, p.40). Project-based learning can confer social benefits upon students: increased group work skills and more enjoyment compared to traditional approaches (Kaldi et al, 2011) and a sense of collective efficacy (Cheng et al, 2008). But, it may have differing effects depending on student academic achievement levels. Cheng et al found that when group dynamics were poor, high achievers reported lower collective efficacy than did low achievers. In terms of learning outcomes, Han et al (2015) demonstrated that when STEM project-based learning programs were implemented once in every six weeks for three years, growth in math scores for low performing students were higher than was the growth of middle and high performing students.

Though problem- and project-based learning can encompass social-emotional aspects, like self-efficacy and confidence, other approaches center these aspects in their objectives for students, with the primary goal of supporting youth in becoming engaged and active members of the community (Lerner et al, 2003). Positive Youth Development (PYD) takes a strengths-based approach, viewing youth as assets to the community. PYD has been articulated in multiple theoretical models of varying complexity, from Lerner's 5Cs to Benson's 40 developmental assets (Shek et al., 2019). Programs using a PYD approach prioritize community collaboration and establish ways that youth can connect to people and institutions within their community (Lerner et al, 2005); and PYD has served as the pedagogical foundation for national programs like 4-H (Arnold & Gagnon, 2020). At the K-12 level, and for teens in particular, programs that

used the Lerner's five tenets of PYD (competence, confidence, character, connection, and caring) demonstrated a positive impact on student attitudes towards civic endeavors. Programs that offered students "real world" experiences contributed positively to students' development as leaders (Bush et al, 2019). The success of PYD programs, as well as many others using different models for youth leadership development and youth empowerment, rests largely on the supportive environment and network of relationships that program staff build to surround youth. Operationalized, this includes directly inviting individuals to participate, asking youth for their ideas, and giving youth meaningful roles within a program or project to provide them with real-world opportunities to engage their communities (Hastings et al, 2011). Creating supportive environments also means that program leaders need to maintain high expectations and support youth in meeting expectations, and they need to promote teamwork and peer-to-peer accountability (Bean et al, 2017; Salusky et al, 2014). Programs should aim to use learning activities that feel distinctly different from youths' school environment (Zimmerman et al, 2011) and incorporate youth choice to the extent possible (Bean et al, 2017). Positive relationships between youth and program-affiliated adults positively influence how youth interact with one another (Bean et al, 2017) and have been positively correlated with increased community contributing behaviors by youth (Ramey et al, 2017).

Fostering problem-solving by students requires understanding the dynamic cognitive and socio-emotional aspects of being a learner. In the next section, I discuss how transdisciplinary approaches to learning can provide a rich context for creative thinking, collaboration, and developing disciplinary identities that further enhances problem-solving abilities.

Transdisciplinary Learning

Transdsciplinarity takes a *whole is greater than the sum of its parts* approach to collaboration among fields of knowledge (Hammer & Soderqvist, 2001; Herro & Quigley, 2017; Stokols, Misra, Moser, Hall, & Taylor, 2008; Vanasupa, McCormick, Stefanco, Herter, & McDonald, 2011). More often referred to as STEAM in K-12 settings, transdisciplinarity aims to not just integrate multiple disciplines, but to create perspectives and problem-solving techniques that transcend any single discipline. Students can be at the center of a transdisciplinary learning practice through engagement in complex cognitive processes beyond just skill acquisition (Bequette & Bequette, 2012; Connor et al., 2015). Transdisciplinary practices that provide opportunities for open-ended creativity and that allow students to bring to the science classroom lived experience and skills associated with non-science activities have been effective at the undergraduate (Bozzone and Doyle, 2017), middle school (Shanahan & Nieswandt, 2009) and high school levels (Shaw, Fields & Kafai, 2019). For example, Bozzone and Doyle documented student success through the creation of courses for non-science majors that allowed them to study biology in the context of the liberal arts, meeting an undergraduate science requirement while having students address the question, *What does it mean to be human?* Through lecture, lab, and community integration activities, the researchers/instructors prioritized the interactions of biology, social science, and humanities in students' exploration of the guiding question, but made the understanding of biological concepts essential to that process. Researchers/instructors observed students making connections across disciplines, capably performing science in a lab context, and successfully teaching course concepts to younger students in the community. The course's centering of student stories of lived experiences guided students in their biological inquiry and the scientific process.

Despite the potential of transdisciplinary/STEAM approaches in K-16 education, several logistical and conceptual factors create barriers to their effective implementation. Logistical barriers include lack of adequate space, resources, and time. STEAM approaches require appropriate facilities, materials, and technology that can support this type of instruction (Stokols et al., 2008). Also essential is a schedule that allows educators from different departments to co-teach courses and accommodates the time-intensive work of planning and maintaining a collaboration (Costantino, 2018). Like logistical components, conceptual factors challenge transdisciplinary/STEAM approaches. Because literature describing and quantifying transdisciplinary techniques is dispersed, researchers and practitioners from different disciplines may lack a unified direction in how to implement transdisciplinary work (Lang et al., 2012), foregrounding fundamental issues of communication, understanding, and interaction among disciplines. These disciplines may have distinct epistemologies and professional cultures. Undertaking a STEAM collaboration requires educators to have a high degree of content knowledge in their own discipline, a general understanding of collaborators' disciplines, and the ability to see connections between disciplines in a problem-solving context (Herro & Quigley, 2017). In fact, "disciplinary egocentrism" occurs when educators fail to see or acknowledge differences and connections between disciplines (Connor et al., 2015). This lack of vision can limit the solutions available to students and short-change one or more of the disciplinary collaborators (Bequette & Bequette, 2012; Herro & Quigley, 2017).

Each discipline relies on specific, and sometimes insular, vocabulary, lines of inquiry, and reified assumptions about the world. These elements influence how that discipline is taught and how it interacts with other disciplines (Costantino, 2018; Hammer & Soderqvist, 2001). Vanasupa et al. (2011) frame the push and pull of transdisciplinary collaboration well:

> In many ways, disciplinary identity directly opposes transdisciplinary collaboration through the habits of mind that it instills. A disciplinary viewpoint by definition is a set of identifiable ways of knowing, views of reality, individuation, and methods for understanding. Transdisciplinary work will necessarily involve differences of viewpoint. However, these differences are largely invisible because they are embedded in the intellectual habits gained through our disciplinary enculturation. It is the working together that surfaces these hidden differences and enables the individuals involved to deconstruct the nature of their own viewpoints. (p.182)

Simply agreeing to work with experts in other disciplines does not guarantee a successful transdisciplinary collaboration. Rather, the literature suggests some core interpersonal and intrapersonal components required for transdisciplinary/STEAM implementation to work. Participants need to establish trust and intentional collaboration parameters, acknowledging that such a collaboration will be time-intensive. Viewing conflict as both inevitable and an opportunity to learn, collaborators also need to be self-reflective and questioning of discipline-centric biases (Stokols et al., 2008; Vanasupa et al., 2011).

Students who can think across disciplines and see the value in collaboration are better positioned to address complex global crises, and STEAM/Transdsciplinarity takes a *whole is greater than the sum of its parts* approach to collaboration among disciplines. In the next section, I present a closer examination of the art-science collaboration in particular, in order to articulate the often-overlooked role that the arts can play in learning and problem-solving and to emphasize the importance of their inclusion in transdisciplinary approaches.

The Role of the Arts in Inquiry and as Science Collaborator

Throughout human history, human survival has been predicated on an understanding of the natural world, and nature has been foundational to the development of culture and the arts. The overlap and connection between art and science throughout history cannot be overstated (Ford, 1993), and these approaches to inquiry and problem-solving have become siloed only in recent times. “Those who discover an explanation are often those who construct its representation” (Tufte, 1997, p.9). Observation, discovery, and visual depiction could be described as simultaneous processes in the work of Galileo and Leonardo da Vinci (Tufte, 1997; Tufte, 1990). Engaging in concurrent artistic and scientific practices has been essential to the construction and expansion of scientific knowledge, as well as the interpretation and marketing of scientific ideas to the public (Ford, 1993). Natural history illustration has long been an arena where women, though frequently without being given credit, were able to contribute greatly to our understanding of taxonomy and natural history phenomena (Reitsma, 2008; Mee, 2004; Fleming, 2016). Countless explorers’ sketchbooks have served as primary sources for cartography, species identification, and anthropological first encounters (Lewis-Jones & Herbert, 2016; Wulf, 2015); and a handful of paintings were instrumental in convincing the U.S. government to create the world’s first national park in 1872 (*Thomas Moran*, 2018). Since the early 1960s, NASA has collaborated with artists in an effort to interpret and explain mission data to the public (Almeida, 2017). The intellectual rigor and creativity found within contemporary science visualization is well represented by the work of Edward Tufte, who has codified principles of graphical excellence (Tufte, 1983). Very much a transdisciplinary process, Tufte states that, “To envision information – and what bright and splendid visions can result – is to work at the intersection of image, word, number, and art” (Tufte, 1990, p.9).

This intersection can be seen elsewhere today, and it is representative of how the arts can act in the service of science and science in the service of art. Within the scientific community over the past decade, there has been a push to embrace aspects of narrative storytelling when communicating with the general public and when publishing in peer-review journals (Atkins, 2016; Krzywinski & Cairo, 2013). Recent multidisciplinary collaborations have explored the permeability between science and popular culture, looking for arts-based ways to engage the public in science (Kaiser, Durant, Levenson, Wiehe, & Linett, 2014). High-profile projects, such as the National Science Foundation grant award to the Rhode Island School of Design (Maeda, 2013) and contemporary philosopher Bruno Latour's work with climate scientists (Kofman, 2018), have provided momentum to the transdisciplinary/STEAM movement. Numerous opportunities currently exist for artists to collaborate with scientists through science-based residencies: the Schmidt Ocean Institute Artist-at-Sea Program, National Science Foundation's Antarctic Artists & Writers Program, National Parks Art Foundation, San Francisco Solid Waste Transfer and Recycling Center's Recology Program, MIT Center for Art, Science & Technology, and the UC Berkeley Center for Science, Technology, Medicine, and Society's Art+Science in Residence Program, to name just a few.

Regarding the climate and biodiversity crises in particular, contemporary artists are using science concepts and data as sources of information, foundations for a call to action, and as springboards to wider inquiry. Artist Rosamond Purcell, who photographed museum specimens of extinct and endangered species states that "The museum has its methods, but with all due respect, the system often has a way of closing out the cosmos from which each creature came…. Science may classify, but art rearranges" (Purcell, 1999, p.151). Examples of these "rearrangements" by other artists include a 400-page graphic novel about climate change that is a

blend of hard science as well as emotional reaction to the overwhelming complexity of the crisis (Squarzoni, 2014); a series of research-themed cakes that interpret the science taking place at the McMurdo Station in Antarctica for a non-science audience (Vaugh, 2019); and knitting patterns based on data that produce garments to tell stories about science, created by an artist who holds a PhD in Zoology (Fleerackers, 2019).

There are also instances where science takes its inspiration from art. The fields of virology, mathematics, and computer science have all benefitted from a technique or structure first employed by an artist (Root-Bernstein, 2000). Artists and scientists may independently develop similar methodologies, as is the case with the use of reductionism in both brain science and abstract painting: reductionism has helped to focus more narrowly on a complex problem in science and been employed by artists to provoke a response in a viewer (Kandel, 2016). And, the link between visual art and brain science is potentially reciprocal (Zeki, 2001). Visual art explores and pushes the brain's perceptual abilities, and brain science has revealed that human vision itself is a creative act, with the brain constantly adjusting, filling in details based on past experiences, and creating new meaning (Fineberg, 2015). Thus, as painter Mark Rothko states, "A painting is not a picture of an experience. It is an experience." (Kandel, 2016, p.130). The emerging discipline of neuroesthetics is the result of this reciprocal exploration of the visual arts and brain science (Zeki, S. (2001).

Discussions about creativity are typically relegated to the arts, but research suggests that highly successful scientists often cultivate avocational abilities in a craft or an art (Root-

Bernstein et al., 2008). Creativity, problem-solving, and synectic thinking[1] are things both artists and scientists have in common. “The more ways students can imagine an idea, the better their chances of insight. The more ways they can express that insight, the better their chances that others will understand and appreciate it” (Root-Bernstein & Root-Bernstein, 1999, p.319).

Looking beyond the inquiry process itself, research demonstrates that engagement in the arts may confer emotional and cognitive benefits to participants. For example, participating in art activities has been shown to reduce stress levels (Abbott, Shanahan, & Neufeld, 2013; Kaimal & Muniz, 2016), mitigate the effects of illnesses related to stress, and reduce the risk of dementia (Gutman & Schindler, 2007). Additionally, art-making activities can positively influence mood repair (Drake & Winner, 2012) and psychological resilience (Bolwerk et al., 2014), help lessen negative feelings in those suffering from depression; and facilitate a meditative-like state without requiring specific meditation instruction (Corkhill, Hemmings, Maddock & Riley, 2014). Suggesting that mastery of an art-based skill may impact motivation to learn, a survey of over 3,500 people who engaged in knitting indicated that over half the respondents believed that knitting served as a springboard to learning new skills (Corkhill, Hemmings, Maddock & Riley (2014). And, the brain-eye-hand connection present in visually creative endeavors appears to confer a cognitive advantage to participants, even when those endeavors are relatively meaningless: Andrade (2010), in a ground-breaking study, found that subjects who doodled exhibited greater concentration and recall when compared to those who did not doodle.

[1] I define synectic thinking as “the process of discovering the links that unite seemingly disconnected elements. It is a way of mentally taking things apart and putting them together to furnish new insight for the solution of problems in both art and industry” (Roukes, 1988, p.11).

Bolstering this finding are studies that underscore how traditional handwritten notetaking, an activity that more closely approximates drawing than does typing on a keyboard, results in greater activation of brain networks (van der Meer & van der Weel, 2017; Ose Askvik et al., 2020; Umejima et al., 2021) and better performance on conceptual questions (Mueller & Oppenheimer, 2014) when compared to notetaking done on a keyboard. Brewin and Lennard (1999) found that handwritten accounts of stressful events induced stronger emotional responses in study participants than did typing similar accounts. "Sensory-motor information for the control of (pen) movement is picked up via the senses, and because of the involvement of the senses they leave a wider mark on establishing pathways in the brain, resulting in neural activity that governs all higher levels of cognitive processing and learning" (van der Meer & van der Weel, 2017, p. 8).

Despite the centuries-long history of collaboration between art and science, the important role of the arts in inquiry is often overlooked. The arts also confer cognitive and emotional benefits to participants that may contribute to problem-solving. In the section that follows, I similarly explore the role that nature-based education plays in providing students with cognitive and social-emotional benefits that further contribute to problem-solving abilities.

The Importance of Outdoor or Nature-based Education and its Connection to Transdisciplinary Learning

Ecological literacy, foundational to addressing an array of global crises now and in the future, presents a particular challenge to educators because "we have come to believe that education is solely an indoor activity" (Orr, 1992, p. 87). In many ways, this is also reflected

within academia and society. Despite the fact that natural history[2] has been foundational to the history of science, deeply informing many disciplines and arenas of public policy like human health, food security, and conservation, its role in research and education and its use in policy-making has been in steep decline for decades (Tewksbury, 2014). This disconnect between culture and nature is further exacerbated by the erosion of nature-based language, skills, and traditions that has followed the rapid urbanization of landscapes and the boom in digital technology. For example, research has demonstrated that use of GPS-based navigation systems, such as those found on smartphones, may impair spatial learning and cause atrophy of our brains' innate wayfinding capabilities (Hejtmánek et al., 2018; Ishikawa et al., 2008; McKinlay, 2016; Willis et al., 2009). Another example of this erosion is evidenced by the 2008 edition of the *Oxford Junior Dictionary*, which cut many nature-based words, such as *acorn*, *otter*, and *pasture*, to make room for tech-based words like *blog*, *celebrity*, and *voice-mail* (Macfarlane, 2015). Nature writer and Cambridge scholar, Robert Macfarlane, states in response to this erosion of our connection to nature, "The substitutions made in the dictionary – the outdoor and the natural displaced by the indoor and the virtual – are a small but significant symptom of the simulated life we increasingly live….A basic literacy of landscape is falling away up and down the ages" (Macfarlane, 2015, p.3-4).

Though this "falling away" is occurring, researchers and practitioners have been producing a substantial body of evidence that demonstrates the ways that spending time in nature benefits mental and physical health (Bowler et al, 2010; Louv, 2005). A movement among

[2] Natural history: "the observation and description of the natural world, with the study of organisms and their linkages to the environment being central" (Tewksbury, 2014, p.300).

pediatricians to “prescribe” time in nature as a way to increase physical activity mirrors a similar trend in adult health care (McCurdy et al., 2010). Nature-based and eco-therapies have been developed to facilitate coping strategies in a dynamic setting and to foster physical, emotional, social, and spiritual awareness (Beringer, 2004; Berger, 2008). Championed by Richard Louv, who coined the phrase *nature-deficit disorder* in his seminal book *Last Child in the Woods* (2005), much of this research is accessible to the public online through the Children & Nature Network (https://www.childrenandnature.org).

An awareness of the importance of outdoor space to human health and student achievement has reached federal and state levels. Three programs from three different federal government sectors serve as strong examples of an outdoor learning ethos at the federal level. The Every Kid Outdoors Act (H.R. 3186), signed into law with bipartisan support in 2019, authorized for seven more years an Obama-era program providing free admission to fee-based public lands for every US fourth grade student. A second example, specifically targeting schools, is the U.S. Fish & Wildlife Service’s Schoolyard Habitat Program, which provides funding, technical support, and teacher training for individual schools that wish to create native plant habitat on a section of their campus (U.S. Fish & Wildlife Service, 2019). And third, the U.S. Department of Education’s Green Ribbon School Award annually recognizes schools, districts, and institutions of higher education for their achievements in environmental impact reduction, improved health and wellness of students and staff, and environmental and sustainability education (U.S. Department of Education, 2019). At the state level, the passage of AB 1548 in 2003 eventually resulted in the creation of a rigorous K-12 environment-based curriculum, approved by the California State Board of Education and now correlated with Common Core and Next Generation Science Standards (California Education and the Environment Initiative, 2019).

Another example of an outdoor ethos at work at the state level, the State Water Resources Control Board's Drought Response Outreach Program for Schools (DROPS) provides funding to K-12 public school districts for projects that reduce stormwater pollution and include education/ outreach efforts to engage students and the public in better understanding water conservation issues (California Water Boards, 2019).

Outdoor learning opportunities and environmental education strategies span a range of formal or informal settings and can serve as a safe entry point to nature, linking it to academic achievement and long-term environmental stewardship (Monroe & Krasny, 2016). In my study, I use the definition of environmental stewardship proposed by Bennet et al. (2018): "Local environmental stewardship is the actions taken by individuals, groups or networks of actors, with various motivations and levels of capacity, to protect, care for or responsibly use the environment in pursuit of environmental and/or social outcomes in diverse social-ecological contexts" (p. 599). Ardoin, Bowers, and Gaillard (2020) refer to environmental education as an interdisciplinary endeavor, "…a conservation strategy that creates such synergistic spaces, facilitating opportunities for scientists, decision-makers, community members, and other stakeholders to converge" (p.1). Effective environmental education programs are those that allow students to be active participants in real research and engage students over a prolonged period of time (Adams & Savahl, 2017), and many educators see the value in outdoor learning experiences as a way to provide students with fun, authentic, experiential learning (Waite, 2011). Outdoor, place-based opportunities can help students develop science identities (DeFelice et al., 2014), develop positive social relationships with peers, mentors, and family (Fifolt et al., 2018), and foster an interest in future involvement in stewardship activities (DuBois et al., 2018). Key factors that create positive attitudes towards nature and environmental stewardship include

positive experiences in nature and role models that engage them in nature-based activities (Chawla, 2007; Chawla and Derr, 2012; Sivek, 2002), both of which can be encompassed in outdoor learning programs. Environmental education programs, particularly those that employ environmental action, also serve as contexts to incorporate PYD strategies, creating "feedback loops" for youth that further develop knowledge, skills, and habits (Monroe & Krasny, 2016, p.150).

Outdoor learning opportunities also have considerable potential to engage students in ways of knowing that are alternative and/or complementary to STEM practices. Western science traditions prioritize the notion of objectivity and are historically linked to colonialism, such that other ways for learners to create meaning may be overlooked in outdoor education programs that emphasize environmental science (Lawson, 2018). The incorporation of transdisciplinary learning into outdoor education programs may not only provide an entry-point for culturally relevant pedagogy, but also offer students the opportunity to explore other ways of knowing, engaging in reflective and contemplative learning practices that call into question epistemologies and identities (Deringer, 2017; Lee, 2017). The acknowledgement and use of Traditional Ecological Knowledge (TEK) in combination with Western science practices is a recent development within the conservation science community (Anderson, 2005; Kimmerer, 2013; Rinkevich et al, 2011), and we can see its use in educational settings as well. Examples of outdoor STEM learning combined with culturally relevant practices include Native Science Field Centers, where Western science concepts are taught in conjunction with traditional Native ways of knowing the world (Augare et al., 2017); internship programs for Indigenous scientists, like the Rroulou'sik Research Experience for Undergraduate Program offered through Humboldt

State University; and NASA's STEM learning collaboration with the Navajo Nation (Allen, 2016).

Though the long-overdue acceptance of TEK is a relatively new development in science and science education, the concept of other-ways-of-knowing is woven throughout the history of natural sciences and outdoor education by their connection to the tradition of nature writing. In this genre, the cultural and the personal are rooted in a sense of place through lived experience and observation of the natural world. "Everything I describe took place while I was watching it, but I do not believe that honest observation is enough. The emotions and behavior of the watcher are also facts, and they must be truthfully recorded," wrote J.A. Baker, author of the nature writing classic, *The Peregrine* (1967, p.14). This genre offers a rich resource from which educators can draw and models how educators and students can engage in place-based, contemplative learning practices. "The human lived body is not merely a curiosity of abstract philosophical reasoning, but a concrete site for EE [Environmental Education]" (Pulkki, Dahlin & Veli-Matti, 2017, p.218). Contemplative learning practices, like mindfulness, can be their own form of inquiry, leading students to question and possibly reject imposed societal norms and construct new meanings (Deringer, 2017, Hart, 2008). These practices enhance abilities that can be used in tandem with the rational-empiricism of STEM, such as concentration, awareness, self-calming, and empathy (Hart, 2008; Pulkki, Dahlin & Veli-Matti, 2017). And, the senses and lived experiences are foundational to identity development.

Nature-based learning not only has the potential to confer mental and physical health benefit upon students, but it is fundamental in students' ability to even recognize the existence of ecological crises unfolding within their lifetimes. Such learning also provides a context for students to engage in other ways of knowing outside of traditional disciplinary approaches. Other

ways of knowing may also contribute to students' creative abilities. Transdisciplinary and nature-based approaches can play an important role in student learning and development as problem-solvers. In the next section, I examine the lack of equity in access to these kinds of learning opportunities.

Access to Opportunities for Building Disciplinary and Nature Identities Is an Equity Issue

Access to opportunities that allow students to build disciplinary and nature identities is not equitable among all groups, mirroring larger inequities seen in school systems and society.

> [S]cience and science-learning settings are enmeshed with larger social structures (race, class, and gender) which present even greater barriers for competent and interested girls, women, and all people of color to become scientific. Youths' alienation from science is problematic not only because a strong foundation in science prepares youth for satisfying, well-paid jobs, but also because it prepares them to serve society by taking on social problems.… Youths' alienation from *nature* is also problematic because of issues of environmental justice in communities that have been disempowered by a lack of access to and education about the natural world. (Carlone et al., 2015, p.1525-1526, emphasis authors')

In settings as diverse as makerspaces (Calabrese Barton et al., 2017), community clubs (Calabrese Barton & Tan, 2010; Polman & Miller, 2010), and classrooms (Van Horne & Bell, 2017; Lee, 1998), students hear implicit and explicit messages about whose knowledge and experience counts and who does what kind of work (Carlone, 2017). Student beliefs in their own academic ability affect their decisions to enter STEM fields (Wang, 2013). Thus, the messages students receive, as well as the systemic barriers they experience in the larger culture, inform

their perceptions of self-efficacy[3], further influencing who they think they can be (Carlone, 2017). This holds true in higher education STEM settings as well, where women and underrepresented minority students have been shown to perceive themselves as less prepared than their peers for graduate coursework (Fisher et al., 2019). In their qualitative study of 24 BIPOC undergraduate students in interdisciplinary environmental and sustainable degree programs, Schusler et al. (2021) found that students' interest in their majors was rooted in seeing the connection between human and environmental health. However, the students felt that major courses lacked adequate discussion about race and the environment, that their majors lacked faculty and student diversity, and they described experiencing discrimination while at their institutions.

Minority groups face challenges in accessing a range of academic and career pathways (Charland, 2010; National Science Foundation, 2017). Low-income students of color receive fewer academic opportunities that prepare them for success at post-secondary institutions (Crisp et al., 2009), and they may feel that their school community does not support their academic success (Vega et al., 2015). African-American and Hispanic professionals are underrepresented in STEM fields, as are people with disabilities. Women in general are also underrepresented in STEM degree programs and the STEM workforce, markedly so in computer science, physics, mathematics, engineering, and economics (National Science Foundation, 2017). Within environmental nongovernmental organizations, women are underrepresented in top leadership positions, while minorities are underrepresented within all strata of these organizations (Taylor,

[3] "Perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations (Bandura, 1982)."

2015). Students of color, in particular African Americans, are underrepresented in the visual arts pathways as well (Charland, 2010), a situation reflective of the larger landscape of the art world in which minorities and women are underrepresented. A recent study of the collections of eighteen major U.S. museums revealed that 85% of artists were white and 87% were men (Topaz et al., 2019). In terms of art museum staffing, minorities are underrepresented in all job categories except security, facilities, and finance/human resources, and many job categories are strongly gendered (Schonfeld &Westermann, 2015). Issues surrounding arts funding also indicate profound inequities: 60% of philanthropic arts funding at the national level goes to only two percent of all cultural institutions; local funding trends track national funding trends; and leaders of color are severely underrepresented at philanthropic organizations that make arts funding decisions, with well over 80% of leadership positions being held by white people (Helicon Collaborative, 2017). These inequities within the funding system impact a wide range of arts programming, from gallery exhibits to outreach to internships.

"[P]eople are formed in practice, within communities of practice that have histories of participation" (Carlone et al., 2015). Developing a positive attachment to the natural environment is a prerequisite to developing the kind of problem-solver who can recognize and engage in complex environmental issues. People from communities of color are less likely to participate in outdoor recreation (Lee et al., 2001), visit the national park system (Scott & Lee, 2018), and are also less likely to engage in informal STEM learning opportunities at museums (Dawson, 2018). Research attributes the disenfranchisement of communities of color from natural spaces to past formal policies of discrimination, a climate of actual or potential discrimination, economic constraints impacting available time and access to transportation (Scott & Lee, 2018), and lack of collaboration with local communities on the part of outside groups or

city governments (Carmichael, 2019). Taylor (2018) critiques the theoretical framework itself that encompasses formal study of minority communities' historical and current connection to nature as also contributing to disenfranchisement.

Physical access to nature is not equitably distributed. Throughout the U.S., non-white communities experience higher than average human modification to natural landscapes, an indicator of habitat loss and fragmentation (Landau et al., 2020). In Los Angeles, affluent neighborhoods have denser tree canopy and substantially higher numbers of foraging birds than do lower-income communities (Wood & Esaian, 2020); thus, lower-income communities have fewer opportunities to benefit from connections with plants and associated wildlife as part of daily life. Access to nature also extends to who is allowed to use open space and how they are allowed to do so, with racial profiling influencing outdoor recreational play for children, particularly Black adolescents (Pinckney et al., 2018). Low-income students of color may also feel that their communities are unsafe (Vega et al., 2015). A sense of feeling unsafe affects students' outlook on environmental stewardship – students may believe that humans are incapable of protecting nature, and/or that nature is a dangerous space to be in (Adams et al., 2016).

Lived experience is rooted in a physical place and a social context. "Environmental identities inevitably contain a social component because they depend on and ultimately contribute to social meaning. How we understand ourselves in nature is infused with shared, culturally influenced understandings of what nature is – what is to be revered, reviled, or utilized. Social variables affect how much we interpret what we see (Clayton & Opotow, 2003, p.10.)." While providing science knowledge or information about environmental crises to people is important, it is not adequate to change environmental behaviors (Bray & Cridge, 2013). A sense

of connectedness to the natural world is vital, but also malleable, influenced by factors such as personal belief systems, experiences with nature (Shultz & Tabanico, 2007), age (Hughes et al., 2019), and social context (Fielding & Hornsey, 2016). The very act of spending time in nature makes people feel more connected to nature (Mayer, 2009). Those who spend recreational time in nature reported more positive environmental behaviors, and this trend held true for both low and high socioeconomic status groups in the UK (Alcock et al., 2019). Additionally, community cohesion may be influenced by the quality of nature experiences that residents have access to in their local area (Weinstein et al., 2015). Childhood nature experiences in particular have long-term influence on environmental identity. Evans et al. (2018), in their longitudinal study of mothers and children in rural New York, found that time spent outdoors in childhood was a predictor of pro-environmental behaviors in young adults. Similarly, Wells & Lekies (2006) demonstrated that childhood time spent hiking, camping, hunting, and fishing was positively correlated with positive attitudes towards the environment in adulthood.

Though having the opportunity to develop an attachment to place can profoundly influence environmental identity, "Place-based science conflicts with efficiency models in education because it requires students to not only acknowledge the local and/or traditional knowledge about the environment in which they live but also to re-learn and re-develop a relationship with it" (Kuwahara, 2013, p.192). In her qualitative study of high school students in Hawai'i, Kuwahara found that a place-based science course contributed to students forming a positive place attachment, which they did not have prior to the course. The author also suggests that interaction with nature should be added to Maslow's Hierarchy of Needs. Similarly, Beltran et al. (2020) found that within UC Santa Cruz's ecology and evolutionary biology major, field

courses were associated with higher levels of student self-efficacy than were lecture-based courses.

Environmentally oriented problem-solvers must have the opportunity to build key competencies beyond just access to environmental knowledge, such as Connectedness With Nature (CWN). In their interdisciplinary review of the topic, Zylstra et al. (2014) contend that CWN "is a stable state of consciousness comprising symbiotic cognitive, affective, and experiential traits that reflect, through consistent attitudes and behaviors, a sustained awareness of the interrelatedness between one's self and the rest of nature…it is an enduring appreciation, empathy, and mindfulness of the intrinsic value and shared essence of all life…" (p.126). People demonstrate CWN through commitment to pro-environmental actions. Another key competence required by environmental problem-solvers may be "constructive hope." Founded on "positive re-appraisal, trust in different societal actors, and trust in the efficacy of individual action" (Ojala, 2012, p.628), it has been shown to positively influence pro-environmental behavior in Swedish teens and young adults (Ojala, 2012). However, in the context of this study it also is important to examine the wicked problem of environmental inaction, a complex and dynamic amalgamation of structural, cultural, and psychological barriers to individuals taking meaningful environmental action (Kollmuss & Agyeman, 2002; Gifford, 2011). In fact, Gifford contends that even if structural barriers to change were removed, seven "dragons of inaction" would remain: "limited cognition about the problem, ideological worldviews that tend to preclude pro-environmental attitudes and behavior, comparisons with key other people, sunk costs and behavioral momentum, discredence toward experts and authorities, perceived risks of change, and positive but inadequate behavior change" (Gifford, 2011, p.290). Despite the decades-long prevalence of environmental awareness campaigns, knowledge alone does not result in pro-

environmental behaviors (Bray & Cridge, 2013; Kollmuss & Agyeman, 2002). Critiques of evaluation practices in environmental education have focused on the frequent assumption that changes in attitudes necessarily lead to changes in behavior, when in reality a range of factors may influence behavior (Marcinkowski & Reid, 2019). Environmental education program participants may leave a program more knowledgeable and having developed pro-environmental attitudes, while at the same time failing to behave in consistently pro-environmental ways. Thus, science and environmental literacy, while important, comprise just one component to successful environmental problem-solving, with other components or competencies strongly tied to emotions and personal experience.

Social components, from family to broader community, can also profoundly shape environmental identity. Having a mother who exhibited positive attitudes and behaviors towards the environment was a predictor in young adults' environmental identity (Evans et al. 2018). Riggs Stapleton (2015) listed social interaction with peers, community members, and family as a key driver of change in students' environmental identity. In this qualitative study of American high school students visiting a South Asian nation impacted by climate change, Riggs Stapleton suggests that the components of practice, action, and recognition found within social identity theory could influence the development of environmental identity. The combination of both place and social influence on identity can itself be a powerful problem-solving tool. For example, Humboldt State University, the most geographically isolated campus of the California State University system, has developed interdisciplinary place-based learning communities (PBLCs) for first-year STEM students. This program was developed to respond to identity challenges faced by first-year students, many of whom were students of color coming from distant urbanized areas, that may have contributed to low second-year retention, math and science

course opportunity gaps, and lower graduation rates (sprowles et al., 2019). Though only initiated in 2015, preliminary results indicate that participating students have a greater sense of belonging, and that second-year retention and academic success in STEM courses are higher for this group than for the paired non-PBLC, same-major first-year students. Organizations like Outdoor Afro and Latinos Outdoors operate on a similar combination of place and community, providing a foundation of belonging and social connection to engage a broader public in outdoor recreation activities.

Inequities in STEM, the arts, and nature access are evidence of powerful systemic barriers to participation as well as of issues of representation, of who is seen doing what kind of work. Narrowing the focus further, it is also relevant to examine who is made visible, and lauded for, being a leader in addressing environmental issues. Youth climate activist, Greta Thunberg has received widespread media coverage for the international global warming awareness movement she initiated (Thunberg, 2018) and for addressing the United Nations' Climate Action Summit in September 2019 (Chappell, 2019). Thunberg – white and from a wealthy Northern European country - is one of many youth around the world working towards environmental justice, and it has been argued that Thunberg's narrative is prioritized by the media over the narratives and accomplishments of youth of color (Asmelash, 2019; Unigwe, 2019). This argument and its far-reaching ramifications are best expressed by writer Chika Unigwe in her *Guardian* opinion-editorial:

> Yet, frustratingly, these other activists are often referred to in the media as the "Greta Thunberg" of their country, or are said to be following in her footsteps, even in cases where they began their public activism long before she started hers – their own identities and work almost completely erased by a western media that rarely recognises progress

> outside its own part of the world. This tendency of the media to present Thunberg as the one who calls, and the others existing only to heed her call, is problematic, especially for those black and brown activists whose media invisibility leads to invisibility to organisations whose help they could greatly benefit from. This "white saviour" narrative invalidates the impact of locals working in their communities, and perpetuates the stereotype of "the native with no agency" who cannot help themselves. As an African I find these portrayals deeply offensive. It is insulting to present the members of the communities most threatened by climate change as passive onlookers who are only now being spurred on by the "Thunberg effect." (Unigwe, 2019)

Self-efficacy is impacted when "competency goes unrewarded or is punished" (Bandura, 1982, p.141). When viewed through the lenses of equity, access, and representation, the contemporary art-science collaborations described in the previous section of this chapter beg the question as to whom is in a privileged enough position to actually do this collaborative, creative, problem-solving work. Large segments of our population are denied opportunities for academic success, entrance to careers in the arts and STEM, and access to nature, and they frequently remain unrecognized for their accomplishments. As a result, society is drawing from a shallow pool of intelligence, talent, and motivation at a time when we desperately need creative problem-solvers from diverse backgrounds.

Systemic barriers that preclude equitable access to learning and nature-connection opportunities profoundly hinder society's ability to mitigate complex ecological crises. In the section that follows, I examine how informal learning environments can serve as spaces for transdisciplinary and nature-based approaches to foster creative problem-solving by students.

Informal Learning Environments as a Setting for Transdisciplinary Learning and Problem-Solving

Informal learning environments can offer a place, social context, and learning content distinct from school and home, and thus may provide new opportunities for students to engage in creative problem solving and identity development. Museums, parks, nature centers, non-profits, public libraries, and other non-school entities devote considerable funding and staff time to educational programming, and their philosophical underpinnings and overall approach to education may differ widely from one another and from those in formal education settings (Luke & Knutson, 2010). Falk and Dierking (2010) posit that the majority of Americans gain much of their science knowledge outside of formal education settings through a range of free-choice sources. "It is exactly because free-choice learning is not like school that it has such value" (Falk and Dierking, 2010, p.7). The National Research Council (NRC), in their handbook *Surrounded by Science: Learning Science in Informal Environments* (2010), devotes considerable discussion to issues of free-choice, interest, engagement, and identity. The NRC identifies five different types of identities – "explorers, facilitators, professionals/hobbyists, experience seekers, or rechargers" – that staff should take into account when designing informal science experiences (p.95). Community-based science programs and makerspaces can serve to develop students' science and community identities (Calabrese Barton & Tan 2010; Calabrese Barton et al., 2017). Some informal settings offer mentorship and role models that may not exist in the classroom setting, allowing students to broaden their notions about who does what kind of work. For example, Polman and Miller (2010), in their qualitative study of a science outreach program for African American high school students, describe the powerful impact that program staff had, as they "were able to guide both the youth participants and their fellow supervisors in

understanding how to carry out the practices of science inquiry or engineering, while simultaneously embodying the notion that diverse individuals can successfully complete such degrees" (p.912).

Supporting students while they engage in communities of practice that are unfamiliar to them changes how students view themselves (Carlone et al., 2015). Carlone et al. refer to this type of support as "identity boundary work" where students grappled with "their perceptions of who they were (not 'outdoors' or 'animal' kinds of people) and who they were asked to become ('outdoors' and 'animal' people)" (p.1526). In their qualitative study, a diverse group of youth participated in a herpetology-themed summer field ecology program. Though the participants did not initially view themselves as the type of people who would handle reptiles and amphibians in the field, the program provided a supportive environment in which to push students beyond those initial visions of themselves in order to become, through doing, the type of people who did handle reptiles in the field. The researchers emphasize that "the role of emotions in learning and identity work cannot be overstated" (p. 1528).

The work of Luke and Knutson (2010) helps to frame a comparison of informal STEM programs and informal arts program. Focused primarily in the museum setting, Luke and Knutson explain that there is no consensus across the art field on what learning outcomes should be for education programs. While science museum education programing tends to emphasize gaining entry to a community of science practice and developing a discipline identity, arts programming "sees the community more broadly and in a more 'civic' light, rather than as a professional community of practice" (p.233) and prioritizes personal development over discipline identity development. In some ways, this creates an openness surrounding informal art education that may make it more accessible to a wider range of educators and students in

comparison to the content- and skill-driven approach of informal science education. Informal arts programming can range from casual zine workshops for teens at a local public library to well-established, big-budget endeavors like the Art Students League of Denver engaging 200 artists as teachers to an all-ages community of learners. We can connect this arts approach to approaches described in a previous section of this chapter, namely the potential through Positive Youth Development programs and problem/project-based learning to produce knowledgeable young people with problem-solving skills and positive attitudes towards civic engagement. And, both art and science informal education can take place in an outdoor setting and incorporate connection to place and nature as part of the learning goals. The program that was the focus of my study, OASP, is an example of this approach.

The integration of the arts and humanities into contemporary STEM learning to create STEAM, offers a more holistic approach to understanding the world and has in fact become increasingly visible over the past decade in K-20 education (Costantino, 2018; Robelen, 2011). Proponents of the transition of STEM to STEAM argue that it promotes a student-centric approach (Connor, Karmokar, & Whittington, 2015), and engages students in life-long learning practices (Yakman & Lee, 2012). Encouraging innovative thinking through authentic problem-solving (Herro & Quigley, 2017), STEAM can be applied to diverse problem-solving contexts (Guyotte, Sochacka, Costantino, Walther, & Kellam, 2014). STEAM requires participants to engage aesthetic and social approaches that go beyond purely technical solutions to a problem. The arts can serve as an entry point and complement to STEM topics, especially when the goals are increased engagement and achievement in STEM (Kim, Ko, Han, & Hong, 2014; Root-Bernstein et al., 2008; Yakman & Lee, 2012), providing students with the opportunity to connect the personal with science content (Walsh & Cordero, 2019). Conceptual arguments for

transdisciplinary approaches posit that giving equal weight to aesthetic inquiry in STEAM-based programs lends itself well to addressing the complexity of real-world problems (Bequette & Bequette, 2012; Root-Bernstein & Root-Bernstein, 1999) and can allow for co-existing viewpoints and new lines of inquiry when viewpoints are in conflict (Vanasupa et al., 2011). Aesthetic inquiry widens the possibility of novel and unexpected solutions with broader moral implications (Campbell & Dalton, 2019; Guyotte et al., 2014).

However, in the past decade, few published conceptual models and empirical studies have articulated exactly how K-12 STEAM pedagogy is distinct from STEM pedagogy. This poses a challenge to educators looking for formal guidance on how to implement STEAM in their practice (Quigley, Jamil, & Herro, 2017). Little empirical knowledge currently exists to describe and quantify the impact that transdisciplinary or STEAM-based programs have on student learning. Furthermore, we know little about the type of educator support, competence levels, and school culture required for educators to effectively implement STEAM programs (Herro & Quigley, 2017; Quigley, Jamil, & Herro, 2017; Robelen, 2011).

My study aims to add to the understanding of STEAM, examining the nexus of transdisciplinary learning, informal education, and outdoor or nature-based education as a way to foster creative problem-solving by students and students' sense of empowerment to address problems.

Conceptual Framework and the Current Study

This study is founded in a Constructivist worldview. Through an exploratory sequential mixed methods case study, I seek to interpret the meanings that individuals bring to and create from their experiences, acknowledging complexity while looking for patterns (Creswell &

Creswell, 2018). Based on literature from multiple disciplines, the conceptual framework for this study is visualized in Figure 1.

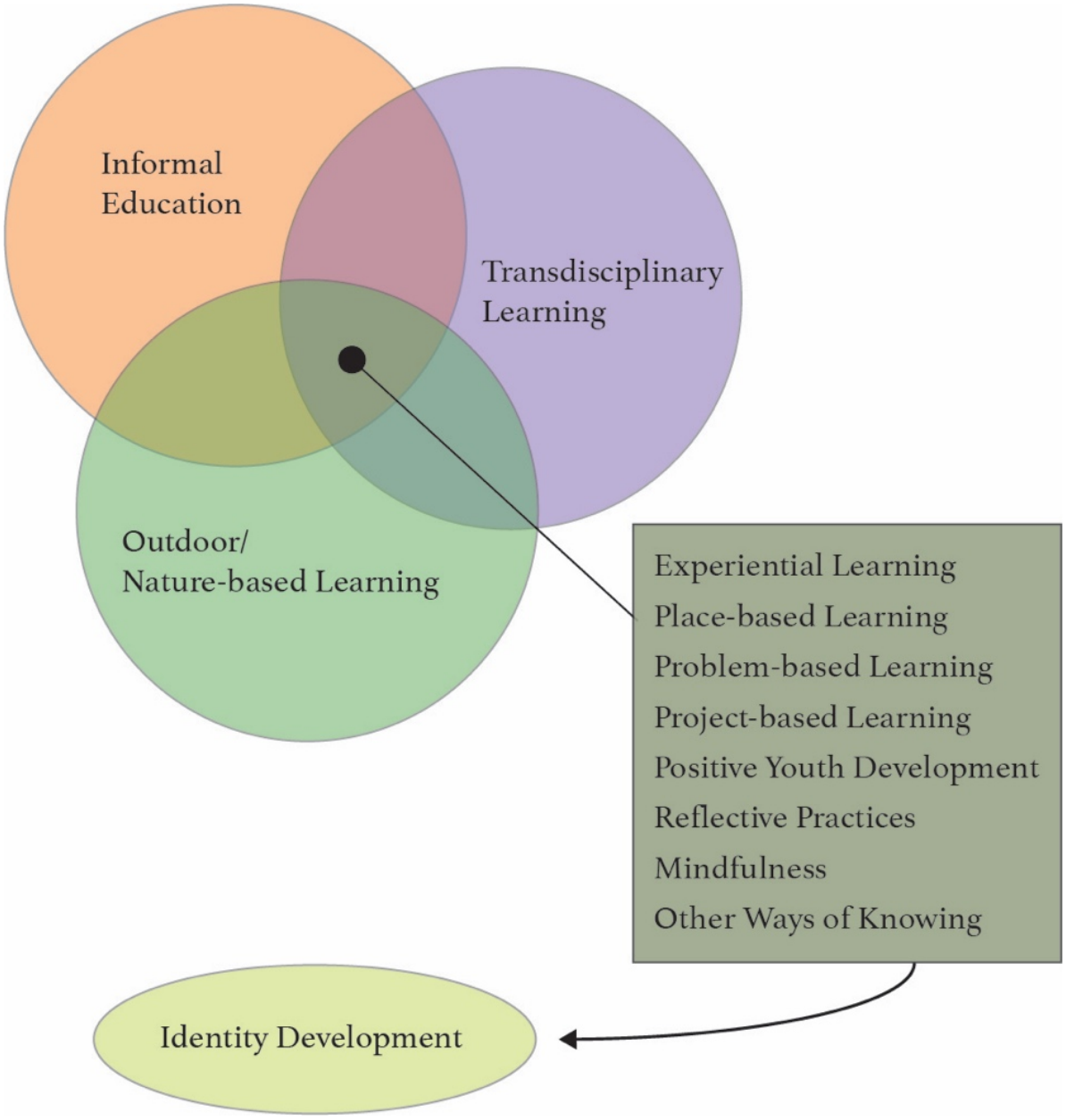

Figure 1. Study Conceptual Framework.

Student identity and its link to learning, particularly in STEM, is currently an active area of research (Bell, Van Horne & Haugan Cheng, 2017; Van Horne & Bell, 2017). However, specifically examining students' "problem-solver" identity at the nexus of transdisciplinary learning, informal education, and the outdoors would be a unique line of inquiry. Informal education programs operate in a context that is considerably less prescribed and regulated than formal education settings. This study aims to examine how an informal education program that combines transdisciplinary learning with outdoor, nature-based components might have the potential to foster problem-solving by students and their sense of empowerment to address problems.

Chapter Three: Methods

This study addressed the following questions:

1. What are the key program elements that influence students' relationship to nature and sense of empowerment to address environmental problems?
2. How do the key program elements influence students' relationship to nature and sense of empowerment to address environmental problems?
3. Following program participation, in what ways do students (a) view themselves in relation to nature and (b) act as environmental problem-solvers in their own lives?

Research Design and Rationale

I used an exploratory sequential mixed methods case study design (Creswell & Plano Clark, 2018). The bounded system for this study was a single program, and this approach employed in-depth description and analysis to better understand the complexity of the case. A case study approach lends itself well to these research questions, as it is nearly "impossible to separate the phenomenon's variables from their context" (Merriam & Tisdell, 2016, p. 38). In this study, the phenomena are the transdisciplinarity and nature-based aspects of the program and students' nature and problem-solver identities. The case study approach allowed me to examine program characteristics and study participant experiences in-depth and attempt to uncover how program elements influenced nature and problem-solver identity. Through qualitative methods, I centered participant experience and personal narrative, using thick description to capture the nuanced complexity of the case. The exploratory sequential mixed-methods approach to this case study allowed qualitative data to inform the development of the subsequent "culture-specific" quantitative instrument (Creswell & Plano Clark, 2018, p. 84). By the end of the study, I was able to articulate what elements of the program fostered participants viewing themselves and

acting as problem-solvers, and how participants relate to nature and engage in environmental problem-solving in their own lives.

Methods

Site Selection Criteria and Rationale

The focal program must incorporate transdisciplinary learning as well as aspects of nature or outdoor learning. I examined a program set in urban Los Angeles, referred to in this study as Outside After-School Program (OASP) to protect the anonymity of study participants. Established in 2008, OASP is managed by a local environmental non-profit organization (referred to as LANPO in this study). OASP engages a highly diverse community of high school students and serves all learners (not solely high-achieving students). OASP typically serves 30-40 students each school year, meeting at a local park 1-3 days a week after school and weekends throughout the school year. The program aims to engage students relatively local to the park. Students earn stipends or community service hours for their participation and can re-apply to the program each year. Field biology and social science methods, reflective and creative writing, observational drawing, graphic design, hand craft, and public speaking are all regularly incorporated into focal program activities. Community leadership opportunities, projects focused on local environmental issues, and collaborations with partners at the regional level are also features of the program. Using this program as a case provided access to an alumni network built over a decade, and it allowed for the opportunity to investigate how this program impacted a range of participants, not just academically motivated students.

Population and Sample Selection

The case study design necessitated a deep level of examination of the program. To this end, I engaged staff members who were also program alumni and program participants who had experienced one or more years of the program. To access OASP for the purpose of this study, I obtained the approval of the non-profit organization that manages the program. Because the study involved consenting participants via the internet, signed consent was not obtained from adult research participants. All study participants, whether staff or non-staff alumni, were under 30 years of age. As described below, I first engaged staff members who were alumni in one-on-one interviews. Then, all non-staff participants completed an online survey and some additionally completed a one-on-one interview. For adults participating in interviews, a written information sheet was provided to them prior to the interview and oral consent was obtained from the research participant at the time of the interview. For adult survey participants, a written information sheet was incorporated into the online survey instrument, preceding the survey questions. For minors participating in the study, I required that they complete a signed parent/guardian consent form prior to participating.

Initial interviews with seven staff members who were also program alumni helped to shape the survey and interview protocols that were then used with the broader study sample population. These participants included all four current program staff members (three female, Latinx participants; one male Black/African-America participant); one former staff member (a female, Latinx participant); and two seasonal staff members (one female, Black/African-American participant; one male, Black/African-American participant).

The non-staff alumni group included high school graduates as well as current program participants who have already experienced one or more years of the program. Students may

repeat the program each year until they graduate high school. The program typically engages 30-40 students annually, comprised of about 50% returning students.

Working from a contact list of program alumni that spanned the program's first year during the 2008-2009 school year through the 2019-2020 school year, 249 alumni were sent the survey link; 80 opted to participate in the survey. The demographics of those who participated in the survey aligned well with overall program demographics (Table 1) and drew alumni from a range of years across the program's history, suggesting a representative sample. Four high schools were represented. The majority of respondents were alumni of Dorsey High School (64%) and Culver City High School (29%), both schools from which the program has typically drawn students over the years. A wide range of education levels were represented: current high school students (14%), high school diploma/GED (14%), some college/associate degree (34%), bachelor's degree (19%), vocational training (1 respondent), graduate/professional degree (2 respondents).

Table 1. *Survey respondent demographics.*

Characteristic	**No. of Survey Respondents**
Gender	
Female	45 (56%)
Male	22 (28%)
Non-Binary	1 (1%)
No Response	12 (15%)
Race/Ethnicity	
Latinx or Hispanic	32 (40%)
Black or African American	17 (21%)
White	7 (9%)
Asian	5 (6%)
Asian, White	3 (4%)
Asian, Native Hawaiian and Pacific Islander	1 (1%)
Latinx or Hispanic, Asian	1 (1%)
Latinx or Hispanic, White	1 (1%)
Native Hawaiian and Pacific Islander	1 (1%)
No Response	12 (15%)

Concurrent to the survey being open to respondents, I interviewed 23 program alumni. Interview participants represent a purposive sample, selected to create a sample that reflected a range of alumni age, race/ethnicity, academic and professional experiences, and representative high schools from which the program typically draws students. I interviewed 12 female and 11 male alumni. Eight participants identified as Latinx, five as Black, two as mixed-race, two as Asian, and the rest as White or other. Their participation in the program ranged from 1 to 3.5 years, with 17 having completed two or more years in the program. Seven graduated from high school between 2009-2014, nine between 2015-2020, and seven were still in high school at the time of the study. All but two attended high school at either Dorsey or Culver City high schools, mirroring the survey sample.

Data Collection Methods

My data collection methods included interviews and a survey. UCLA IRB conditionally approved my study on November 5th, 2020, allowing me to conduct the first part of the study sequence, interviewing seven staff members who were also program alumni. IRB then approved study protocol amendments for the next part of the sequence on January 28th, 2021, which entailed a survey and interviews with non-staff program alumni.

Interviews. Distinct interview protocols were created for program staff and program alumni. Interviews were essential to gather rich, nuanced detail and personal examples from study participants. Protocols were semi-structured, allowing for flexibility of wording and follow-up probing questions. All interviews except one were conducted remotely using Zoom; one interview was conducted by phone. I recorded interviews using a small audio recorder as well as my phone and computer, and I took hand-written notes.

Program staff. The interview protocol designed for program staff members focused on their experience in the program when they were participants as well as their experience as staff members, such as pedagogical practices, curricular themes, changes in practice over time, and observations of and reflections on how the program affects participants. Data gathered from these interviews were used to develop the survey instrument and the interview protocol used with alumni. Thus, staff interviews were the first method employed in this sequential mixed-methods study. Interviews ranged in duration from 26-114 minutes, though only two of the five interviews went over one hour in duration. Staff members received a $10 gift card for participating in interviews. Interviews were conducted between December 8th and December 16th, 2020.

Program alumni. Interview protocols for this group focused on how participants viewed themselves as environmental problem-solvers, their relationship to nature, and how key elements may have influenced their thinking about problem-solving and their sense of empowerment to address problems. Initial drafts of the protocols were based on current literature surrounding problem-based learning, experiential learning, and the psychology of problem-solving. Staff interview data were also used develop the language employed in the protocol. Similar to the survey instrument, alumni were asked to reflect on their time as a high school student and on their post-high school years. Interviews ranged in duration 13-56 minutes and averaged fewer than 35 minutes. Alumni received a $10 gift card for participating in interviews. Interviews were conducted between February 8th and February 25th, 2021.

Surveys. I administered a survey to program alumni concurrent with conducting alumni interviews. Incorporating a survey into the study's methods had multiple advantages. First, surveys were an efficient way to gather information from a much larger group of study participants than I would be able to actually interview. Second, standardized questions and

answers facilitated the use of descriptive statistics, which were helpful in providing a landscape-level view of the program that complemented highly nuanced individual experiences described through interviews. Finally, because surveys were anonymous, they may provide a counterpoint to interviews because participants were not reacting to my real-time presence.

The survey for program alumni focused on examining the alumni connection to nature and ways that they may view themselves as environmental problem-solvers, and it also asked them to reflect on their time as a high school student and on their post-high school years in relation to the program. Staff interview data, current literature surrounding problem-based learning, experiential learning, and the psychology of problem-solving were used to develop the language employed in the survey, specifically regarding what would "count" as problem-solving behaviors and ways of thinking. The survey was developed and distributed digitally through Qualtrics, sent directly to individual alumni through text, email, or Facebook messenger. Anonymity was protected because I did not collect identifying information (such as name or email address) as part of the survey. I sent a reminder communication to study participants about the survey two days prior to closing the survey. The survey was opened on February 4th, 2021 and closed on March 2nd, 2021.

Prior to administering the survey, I first compiled an alumni contact list through existing records, network connections, and social media announcements soliciting participation in the study. The contact list allowed me to track the method of contact for each potential study participant.

Data Analysis Methods

Surveys. Survey data were downloaded from Qualtrics and imported into Excel for analysis. I also imported subsets of the data into JASP to create descriptive statistics and to examine possible correlations between composite variables.

Identifying and Prioritizing Key Program Elements. The survey presented a list of 16 pre-determined program elements and asked respondents to rate how useful and how meaningful they believed each element to be using descriptive Likert scales (Table 2). Both "useful" and 'meaningful" were asked to capture participants' perceptions of element utility and emotional value and acknowledge that the two may not necessarily align. A participant could believe that a program element did not have much utility for them (e.g., activities that were centered on food) but did find it to be meaningful. Conversely, at the time of program participation an element could have negative emotional associations (e.g., teaching others), but upon reflection during the survey a participant may see that they gained a useful skill from it. Utility was rated on a 3-point Likert scale (0 = not useful/applicable, 1 = somewhat useful, 2 = very useful). Meaningfulness was rated on a 4-point scale (0 = not meaningful/applicable, 1 = somewhat meaningful, 2 = meaningful, 3 = very meaningful). I computed an overall score for each element by summing usefulness and meaningfulness ratings for each participant. Combined scores ranged from a 5 (very useful + extremely meaningful) to 0 (not useful/applicable + not meaningful/applicable). The survey also gathered qualitative data about program elements through the free-response prompt, *Briefly describe what you found most valuable about your experience in the program*, helped to focus in on key program elements. Free responses were coded using the same 16 program elements presented in the survey questions, and additional codes were created for responses that fell outside those pre-determined program elements.

Table 2. *Program elements presented in the survey.*

Program elements presented in survey
Working in the community
Learning about nature
Doing hands-on work
Visiting places that were new to you
Spending time outside
Working as a team
Doing real-world projects
Discussions with staff and peers
Receiving a stipend or project funding
Being social with peers
Teaching others
Doing activities that involved self-reflection or mindfulness
Doing science
Getting support with the college application process
Doing activities that involved art or craft
Activities that were centered on food

Survey analysis. Survey data were largely used to provide context for or show alignment with interview data.

To examine relationships among respondents' environmental problem-solving skills/knowledge gained through the program, sense of connection to nature, and sense of empowerment, I created five composite variables from a sub-set of survey items that focused on respondents' time in the program (Analysis 1). I converted Likert scales to numerical values, aggregated the thematically related questions, and created composite variable scores for each respondent by summing their score for each question of the composite. The Action/Empowerment composite variable represented actions taken and respondent sense of empowerment while in the program (Q5.3, Q5.8, Q6.9, Q6.10, Q9.7). The Community Connection variable represented feelings about community and place in it (Q5.4, Q5.6, Q5.7). The Nature Connection variable included sense of connection to nature (Q6.1, Q6.2, Q6.4-6.8,

Q9.10). The Self/Identity variable represented beliefs about self and feelings about how/if the program emotionally supported the respondent (Q5.1, Q5.2, Q5.10, Q7.1, Q7.3-7.8). The Environmental Problem-Solving variable included skills and knowledge that are components of or would aid in environmental problem-solving (Q5.5, Q5.9, Q7.2, Q8.1-8.5, Q9.1-9.6, Q9.8, Q9.9, Q9.11-9.14). The goal was to examine any relationships that might occur among these composite variables. For example, do respondents who score high in the nature connection composite variable also score high in the environmental problem-solving composite variable?

Similar to the analysis above, I also wanted to identify relationships between nature practices/beliefs and stewardship actions, taking into account how participants saw themselves and their sense of empowerment to use skills they had gained. For this second analysis (Analysis 2), I used a different sub-set of survey questions to create four composite variables. The Action composite variable included actions related to influencing others within their immediate community, stereotypical environmental actions, and actions in areas of their life where participants had autonomy (Q14.8, Q15.1-15.6, Q16.14). The Nature Practice variable represented outdoor nature-based activities, indirect nature-based practices that could be done without going outside, and beliefs about nature (Q16.1-16.12, Q16.13-16.17). The Problem-solving Disposition variable included characteristics and habits that are important components to being a problem-solver (Q14.1-14.7, Q15.7, Q15.10). The Sense of Empowerment variable represented characteristics and beliefs relating to sense of empowerment to use skills (Q15.8, Q15.9, Q17.1-17.8).

I used JASP to conduct statistical tests and to produce descriptive statistics. For each of the two analyses, I removed respondents from the sample if they did not complete the entire suite of sub-set questions. All the composite variable scores were non-normally distributed, an artifact

of the overall high scores that respondents gave across all questions in the survey (Table 3). Initially, I employed Pearson's Correlation Coefficient, but given the non-normal distribution of the data, I then used Spearman's Rank-Order Correlation. There were statistically significant correlations among all the composite variables for each of the two analyses, whether tests were parametric and non-parametric. This analytical approach did not help to better answer the research questions, other than to underscore the positive, favorable view of the program held by participants who opted to take the survey. It will not be addressed in Chapter Four, but more details can be found in Appendix E.

Table 3. *Descriptive statistics for the composite variables of Analysis 1 and Analysis 2 of survey data.*

	Max. Score Possible	**Mean**	**Std. Deviation**
Analysis 1 (n=52)			
Action/ Empowerment	14	11.808	2.105
Community Connection	9	8.135	1.534
Nature Connection	23	20.231	2.617
Self/ Identity	30	26.365	3.436
Environmental Problem-Solving	43	32.885	8.050
Analysis 2 (n=65)			
Action	24	18.169	3.827
Nature Practice	48	38.123	6.999
Problem-Solving Disposition	27	23.185	3.097
Sense of Empowerment	30	24.769	3.678

Interviews. Audio-files of interviews were stored on a laptop computer, and transcripts were produced through Rev.com. Personal identifiers were removed from Microsoft Word transcripts to protect confidentiality and minimize my potential bias. To get a general sense of the data prior to coding, I reviewed my interview notes, and then listened to all audio-files while taking notes again and correcting transcripts. Staff interview data were excluded from the analysis of the alumni data set. For alumni interviews, I created a coding system that allowed me

to analyze data across the alumni study participants in a standardized way. Survey and interview protocol informed this base-line level of coding. The survey data analysis process also informed my approach to coding, as I was aiming to create a nuanced, cohesive narrative using both qualitative and quantitative data sets (Creswell & Plano Clark, 2018). For the first cycle of coding, I employed Structural Coding (Saldaña, 2013), which helped me to stay focused on my research questions by initially categorizing by interview question. It also helped me to compare and contrast participant responses out of the context of their individual transcripts. This was especially important because each interview participant was a student I had personally worked with in the past, and first cycle Structural Coding helped to anonymize the quotes and reduce my bias. Reviewing my initial interview notes, re-listening to recordings, and reviewing process notes I took while first cycle coding informed the second cycle coding process. I largely employed Pattern Coding (Saldaña, 2013), and new inductive codes emerged as well. Following Pattern Coding, further iterations of the coding process helped to consolidate or expand categories as needed, and to look for relationships between categories. I used MAXQDA2020 coding software to code alumni transcripts. Features within the software, such as lexical searches and code mapping, were helpful in seeing relationships among codes and categories, particularly where quotes were coded with more than one code. I then used Excel to summarize code frequencies and aggregate exemplary quotes by theme and sub-theme. Analytic memos for each research question were completed during the analysis process.

As part of the process to identify and prioritize program key elements, the following interview questions gathered data specific to program elements: *what comes to mind when you think about the program*; *what are the key elements of the program*; and *which program activities had the biggest impact for you.* I also included any follow-up probing questions that

asked interview participants to describe what program activities had influenced them or why the activity was significant for them. Responses were coded using the same 16 program elements presented in the survey questions, the emergent codes developed from the survey free response analysis, and additional codes were created for responses that fell outside those codes.

Data Management. Data, analyses, and drafts of the final write-up were backed up daily through Backblaze (cloud-based), weekly to a cloud-based password protected drive, and weekly to an external hard drive.

Positionality and Management of My Role

Management of my role posed the biggest challenge. The inquiry process and group discussion are built-in components to the program, such that staff, alumni, and program participants likely saw nothing unusual about a broader study being conducted on the program itself by a staff member. I was everybody's supervisor first, but I attempted to establish a sense of relatability with study participants because, like them, I was also a student. I was as transparent as possible about the goals of the study, and what it was like to be a researcher, without compromising study protocols – I wanted to minimize reactivity. I also was cognizant of issues surrounding power dynamics (see the section that follows). It was made clear to staff, alumni, and current program participants, in writing and orally prior to the interviews, that their participation in the study was entirely voluntary and that they could opt out at any time.

Ethical Issues

Fortunately, my study did not focus on a highly sensitive topic, and there was no need to ask study participants to discuss highly personal information. Additionally, the participants were being asked about how the programs affect their thinking and choices, and they were not being asked questions with a high risk of reactivity, such as whether or not they liked the program or to

evaluate staff members' effectiveness. However, my positionality in the project does raise issues about coercion, especially regarding interviews with staff I supervise. Study participants were reassured, in writing and orally prior to the interviews, that they could opt to leave the study at any time without putting their standing as an employee or program participant in jeopardy. Surveys were anonymous and individual responses were confidential; personal identifiers in interview transcripts were removed. Though I had initially intended to do so, I did not solicit study participants to complete member checks, as I did not wish to ask any more from study participants during the high-stress time of the continued pandemic.

Credibility and Trustworthiness

I was most concerned about bias and reactivity threatening the credibility and trustworthiness of my study. Transdisciplinarity and outdoor learning are practices I have been involved in since my undergraduate days, and I believe strongly in their efficacy as pedagogical practices. Additionally, the focal program is one that I helped establish, grow, and currently manage. Along with dedicating much of my time, I am also emotionally invested in this program and the well-being of the staff and students. It was challenging to distance myself, as I personally know all study participants. However, triangulation through different data collection methods (surveys and interviews) and a range of study participants from different strata of the programs (staff and alumni) should help combat my bias. I used rich data, such as interview transcripts, and removed personal identifiers to counterbalance my bias. I also maintained a study journal to document my own reflexivity during the course of the project.

Studying my own program also posed a major issue regarding reactivity. I directly supervise staff (who are program alumni) and students who were study participants.

Triangulation, as discussed in the previous paragraph, should help to mitigate some effects of reactivity.

Overall, I believe the combination of strategies helped mitigate other threats, such as insufficient evidence and sloppy procedures. I established an audit trail (Guest et al., 2013; Merriam & Tisdell, 2016) that consisted of a project chronology tracking log, screening and data tracking logs, detailed coding and survey data process notes, as well as a handwritten reflection journal. These items allowed me to carefully document and examine my research process and served as important resources when discussing the limitations to my study in Chapter Five.

Study Limitations

The focal program in this case study operates within a very specific context: informal outdoor education programs managed by small, environmental non-profits. Results from this study may not be generalizable to other settings, such as large museums or K-12 classrooms. Additionally, this was an opportunity-based study, with participants opting in to both the survey and interview process. The views expressed by study participants may not be representative of all focal program alumni.

Summary

This exploratory sequential mixed-methods case study examined how, if at all, transdisciplinary programs in an informal education setting that also have outdoor/nature-based components foster problem-solving by students and students' sense of empowerment to address problems. Researchers in the field could use the results of this study to better understand how these types of programs might serve as a driver that shapes student identity. Practitioners could use the results of this study to help students develop identities of being creative problem-solvers who feel entitled to use STEM and arts-based strategies in their daily lives.

Chapter Four: Findings

In this chapter, I present the findings of my exploratory sequential mixed methods case study. My study aimed to examine how a Los Angeles-based informal education program that combines transdisciplinary learning with outdoor, nature-based components influenced, if at all, students' connection to nature and students' sense of empowerment to address environmental problems. The following research questions guided my study:

RQ1: What are the key program elements that influence students' relationship to nature and sense of empowerment to address environmental problems?

RQ2: How do key program elements influence students' relationship to nature and sense of empowerment to address environmental problems?

RQ3: Following program participation, in what ways do students (a) view themselves in relation to nature and (b) act as environmental problem-solvers in their own lives?

I present my findings following the order of these questions. In the first section, I describe 11 key elements of the program, as identified by participants. In the second section, I describe participants' relationship to nature. Relationships to nature manifested as beliefs and feelings about nature and practices of engaging with nature. This section also presents specific key program elements most closely associated with nature connection and describes the program activities that participants indicated had an affected their relationships to nature. I then present participants' positioning as problem-solvers within the program and their sense of empowerment, and the program elements they identified as contributing to that. Finally, I describe the ways that participants reported acting as environmental problem-solvers in their own lives.

Key Program Elements

The initial interviews conducted with the seven staff members who were also program alumni were instrumental in developing a list of program elements to present to survey respondents. However, this set of interviews also suggested that program elements were not clearly defined, they varied from person to person, and there was not a consistent terminology used by staff-alumni to describe program elements. Thus, in order to address RQ1, it remained important to ask survey respondents and subsequent interview participants what they perceived to be key program elements. In this section, through the combination of survey and interview data, I discuss the identification of program elements and describe in detail the 11 key elements that were of primary importance to study participants.

Identifying and Prioritizing Key Program Elements

As described in detail in Chapter Three, the survey presented a list of 16 pre-determined program elements and asked respondents to rate how useful and how meaningful they believed each element to be. The majority of survey respondents indicated that all program element options presented to them were both useful and meaningful. Though a ranking did emerge, the data reflected the overall upper-level ratings respondents provided across survey items (Table 4). The survey tool also gathered qualitative data about program elements through a free-response prompt, and 69 of the 80 survey respondents provided a written response; of those, 43 indicated more than one thing of value. Ten of the 16 pre-determined program elements were represented in the survey free responses, and 14 of the 16 pre-determined program elements were represented in the interviews (Table 4).

All 16 pre-determined program elements received a combined score of 4 or higher by a majority of respondents, with 13 of the 16 receiving a score of 5 by a majority of respondents.

With the exception of *Discussions with staff and peers*, all 16 of the pre-determined program elements were also collectively represented in the qualitative data set. However, mapping the interview data onto the survey results helped to determine the relative importance of the 16 pre-determined program elements presented on the survey. I computed a Rank Score for each element by summing the number of respondents giving an element a Combined useful/meaningful Likert score of 4 or higher, plus the number of survey free-responses and interviewees who cited the element (Table 4).

Table 4. *Program element survey score distributions mapped with survey free responses and interview data.*

	Combined useful/meaningful Likert Score from survey (n=80)		**Survey free responses reporting the**	**Interview Participants reporting the**	**Rank**
Program Element	**5**	**4**	**element (n=69)**	**element (n=23)**	**Score**
Learning about nature	51	22	21	15	109
Spending time outside	55	19	11	17	102
Doing hands-on work	59	11	9	17	96
Being social with peers	48	19	19	12	95
Working in the community	66	7	9	7	89
Visiting places that were new to you	53	18	0	15	86
Teaching others	49	17	5	14	85
Working as a team	54	15	6	7	82
Doing real-world projects	59	13	0	2	74
Discussions with staff and peers	50	21	0	0	71
Doing science	39	23	9	0	71
Receiving a stipend or project funding	48	18	0	2	68
Doing activities that involved self-reflection or mindfulness	50	8	0	3	61
Getting support with the college application process	47	9	3	2	61

Doing activities that involved art or craft	27	20	1	7	55
Activities that were centered on food	28	15	0	2	45

From the 16 pre-determined elements, I selected those with the eight highest Rank Scores as "Key Elements". My criteria for this selection was the 8-point gap in Rank Score separating the elements in eighth and ninth place, and that the top eight elements were represented in 13 or more interviews and/or free responses. In the paragraphs below, I describe each of the top eight Key Elements using participants' own words in survey free responses and interviews.

Learning about nature. "The most valuable experience in the program was gaining an immense amount of knowledge on native plants and animals in my community." This survey free-response was indicative of the majority of participants who referenced *Learning about nature* as a key element. Many participants described learning about local plants and wildlife in particular. Some participants referenced "bigger picture" ecological or environmental concepts, such as drought, water issues, and climate change, as well as learning "why we needed to conserve nature in a specific way, knowing that it's not just one thing, but how the environment sort of work together." Two participants referred to learning about environmental issues through other materials used in the program, such as books and videos.

Spending time outside. Though many participants referenced doing work outside as a component of the program, that "you're going to work outside a lot" and that there was "outdoors stuff", few provided specific details about that experience. Having the opportunity to "step my feet more into nature" specifically at local areas was voiced in four survey free responses. For four interview participants, spending time at the program's regular park work site was an integral

part of their experience in the program: “I just think of like the times up on the hill, just kind of working under the sun, or if it's a cool day, it's just nice and breezy, and it's just very serene.”

Doing hands-on work. When talking about hands-on work in the program, the majority of participants referenced habitat restoration activities that allowed them to, as one participant described, “actually interact with my environment.” Activities such as installing native plants, removing non-native plants, and “a lot of digging and planting” at park restoration sites were often cited. Other activities described included data collection activities in the field, such as bird surveys, vegetation measurements, and soil testing. One participant took a wider view of program activities and experiential learning, “like majority of it involved us participating, um, in an activity that incorporated the environment around us or even with just our bodies, like, you know, it was still made us mind, more mindful of what they're actually trying to like get us to, to educate us on.”

Being social with peers. This aspect was referenced as a key element by numerous participants. The program served as a place, explained one participant, “where I could build relationships with my peers outside of school. This experience has made me feel more connected to the people in my community, the wellness of our environment, and our need to work together to accomplish a better future.” Another participant echoed this feeling, stating that, “I also loved having been able to experience my peers in a setting that was in direct contrast to school studies.” Many participants discussed the opportunity to meet people outside their usual social circle and develop friendships: “What I found most valuable about my experience in the program was having the ability to connect with people I otherwise wouldn’t have had the opportunity to connect with, all through connecting with nature.” The importance of this element was underscored by the fact that 13 interview participants cited a social reason as an influence on

their decision to apply to the program in the first place, in particular that they had friends or siblings in the program. “My girlfriend at the time joined ‘cause of [a teacher],” explained one participant, “and I wanted to spend more time with her, but her parents are Hispanic, so they're very strict, like no boys. So, I'm like the only way I'm going to hang out with her is if I join OASP.” Thus, having the opportunity to be social with peers was an expectation with which participants entered the program.

Working in the community. “I think that OASP was very, uh, community oriented,” explained an interview participant, “...and we were learning directly about our own communities.” Participants who referenced working in the community as a key element for them frequently viewed that community as their own, and that “...being a part of something that benefited the community I lived in made me feel good.” Participants had positive associations with doing community work, believing that they had a positive impact or that they made a difference. One survey respondent linked the visibility of the community work with collective, social effort, stating, “Being able to work with my peers to make a change that I get to see is really special.”

Visiting places that were new to you. The focal program provides opportunities to participate in learning activities away from students’ local communities. One participant stated that the trips, “constantly challenged me and others to get out of our comfort, uh, comfortable, uh, comfort zone, as well as just knowing that there's a whole world of nature and other people who appreciate nature, just like I did.” Though there are multiple trip destinations each school year, the location referenced by nine participants was the beach sites where students learn about the ecology of two bird species on the endangered species list and participate in data collection and habitat restoration in support of conservation. One participant articulated the dual effect that

the trip had on him, stating, "...when I first went there, I thought, I mean, the scenery was really beautiful. And learning more about, like, the birds and, like, the local area. It's just like, it was very shocking. But at the same time, like, well that's kind of bad, we should probably do something about that."

Teaching others. Participants found the opportunity to teach others valuable, especially when the audience was elementary school students. "My most treasured moments were when we worked with the elementary school children," said one survey respondent. Another survey respondent explained that teaching "showed me how influential I can be to those in my community." Beyond the satisfaction of sharing their knowledge, two interview participants described how learning to teach, "how to really take this all the scientific knowledge and really put it into perspective for a public audience to be able to understand it," was itself a useful skill to develop.

Working as a team. Participants referenced teamwork and collaboration as a key element of the program. However, few provided details beyond stating that they believed they "learned to work better within a team" and "shared results and failed together too". Of the very few who did provide more detail, one interview participant described how working as a team was a form of negotiation for her.

> But yeah, I just remember a lot of, um, collaboration, um, working together. Um, and, and, you know, at times, maybe not agreeing on a few things, but coming to an understanding to like compromise, you know. I'll, I'll kinda like, you know, bend an arm for that, if you do this for me. But yeah, it was great. I think it was, it was a way where I was able to feel comfortable and kind of see where I fit in the whole collaboration process.

Survey free responses and interview data captured additional program elements distinct from the 16 pre-determined elements presented in the survey. Ten new codes emerged from the survey free responses: *Career/Major influence*, *Safe Space/Emotional Support/Caring Staff*, *Self-knowledge/Personal Growth*, *Freedom to explore a personal interest*, *Leadership Skills*, *De-stress/Mental Health*, *Multi-disciplinary*, *Networking/Access to Opportunities*, *Communication/Public Speaking*, *Not sure how to classify.* In the interview data set, six of these ten emergent codes were also represented, and three additional codes emerged: *Doing a research project*, *Different than school*, *Diversity of students* (Table 5).

Table 5. *Emergent program element codes from survey free responses and interviews.*

Emergent Element Codes	**Survey free responses reporting the element (n=69)**	**Interview Participants reporting the element (n=23)**
Safe Space/Emotional Support/Caring Staff	10	13
Communication/Public Speaking	7	5
Networking/Access to Opportunities	2	8
Career/Major influence	9	0
Self-knowledge/Personal Growth	12	0
Freedom to explore a personal interest	2	6
Leadership Skills	4	0
De-stress/Mental Health	3	2
Multi-disciplinary	2	2
Not sure how to classify	1	0
Doing a research project	0	5
Different than school	0	4
Diversity of students	0	3

From the above 13 emergent elements, I selected as "Key Elements" those with the highest combined representation in both the survey free-responses and the interviews: *Safe Space/Emotional Support/Caring Staff*, *Communication/Public Speaking*, and *Networking/Access to Opportunities*. In the paragraphs below, I describe each of these three emergent Key Elements.

Safe space/emotional support/caring staff. This emergent Key Element was well represented in both the survey free-responses and in the interviews, and participants were detailed in their descriptions. “The most valuable part of the program was having support from adults who pushed us to try harder. They knew we all had potential to become successful in whichever career/life choice we did. It helped me grow my interest in social justice, environment, and my community - which ultimately pushed me to try harder and be more involved in college.” Participants described the program environment as friendly, welcoming, and encouraging, and expressed feeling trusted, valued, supported, and cared about by staff. Two participants referred to the program community as “family”, and multiple participants referred to the program as a “safe space.” It was a “space to breathe” where “it's okay to not know everything,” and “there was no, no judgment there.”

The importance of *Safe Space/ Emotional Support/ Caring Staff* as a Key Element was also supported by a sub-set of interview data that aggregated participants’ descriptions of the program’s mindset. Twelve participants described the program mindset in terms of being welcoming, inclusive, safe, and positive, and that “you never felt judged.” One participant provided a clear description of how he felt safe in the program.

> When I'm in, when I'm at OASP, um, I feel safe. I feel included. Um, you know, there's been places where I go, it's like, uh, I don't think I belong here, you know. It's a very open and a welcoming space where I feel free to be myself.

Though this Key Element emerged through the coding process, it is also substantiated by survey data as well. A set of questions asked respondents to assess how supported they felt in the program. The majority of respondents agreed or strongly agreed that they felt like they could both be and express themselves at the program, that staff cared about them and wanted them to

succeed, and that the program was a place to escape from challenges at home or school (Figure 2).

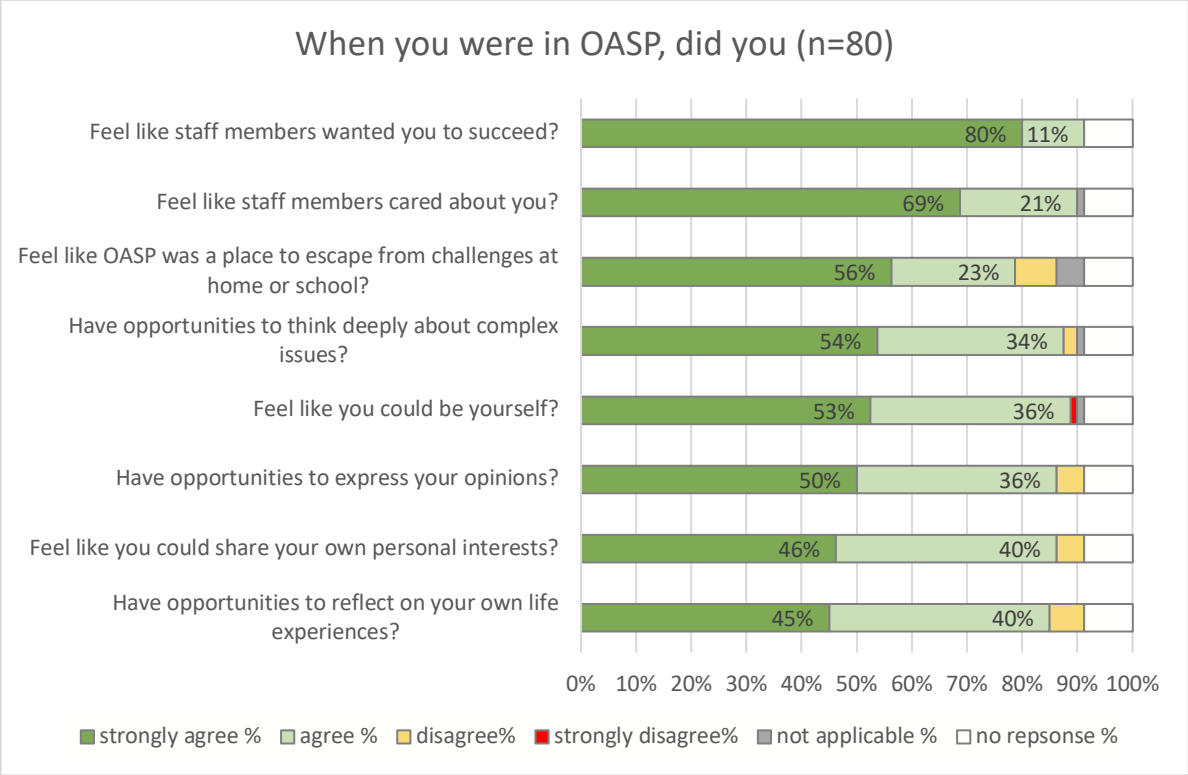

Figure 2. Survey responses to questions gauging how supported students felt while in the program.

Communication/public speaking. Participants describing this Key Element almost exclusively discussed public speaking. From icebreakers to formal presentations, these activities were viewed as ways that participants were pushed to step out of their comfort zone, with one survey respondent stating that they had gained the "ability to speak confidently about my work and feel secure in my ownership of what I had done." One survey respondent articulated multiple aspects of communication in which. she engaged.

> From the program, I found giving presentations after condensed complex lessons valuable, especially when we were in person. This is because in creating and presenting the information with other OASP students, I gained skills such as public

speaking, teamwork, time management, and writing, as all of these skills were needed to create and present our information.

Networking/access to opportunities. "I would convince people like, Hey, if you want to, if you want things to open up for you, join this program." Participants described multiple aspects to this emergent key element. Three participants referenced the opportunity to interact with scientists and better understand career pathways, with one participant referring to the program as a "branch to careers and networking." Another said the program "allowed me tremendous opportunities for scholarships and travel with research I did through this program and at college." Similarly, three participants described opportunities to interact with faculty and students at Cal Poly Pomona. Finally, three participants explained how the program connected them to outdoor recreation trips with other organizations in the National Park system that exposed them to "bigger things outside of our own community."

In sum, study participants described numerous program elements, but I identified 11 as Key Elements that were of primary importance to study participants: *Learning about nature, Spending time outside, Doing hands-on work, Being social with peers, Working in the community, Visiting places that were new to you, Teaching others, Working as a team, Safe Space/Emotional Support/Caring Staff, Communication/Public Speaking,* and *Networking/Access to Opportunities*.

Participants' Relationship to Nature

In this section I first describe study participants' relationship to nature prior to program participation. I next describe participants' nature beliefs and practices. Then, I use both survey and interview data to examine the activities at work within and among the previously identified Key Elements to explore change in participants' reported relationships to nature.

Nature Relationship Before the Program – Where Are Students Starting From?

To better describe how study participants viewed themselves in relation to nature following program participation, I first wanted to understand how they characterized that relationship before program participation. I relied on interview data to provide this information, as the survey did not ask participants about their relationship prior to being in the focal program. Despite the fact that 11 interview participants cited nature and/or being outside as a motivational factor in their decision to apply to the program, the majority of the 23 interview participants indicated that they did not have a strong connection to nature prior to participating in the program. Interview data show that students arrive at the program with different relationships to nature, and four participant profiles emerged from the interview data: *Strong pre-existing connection to nature*; *Awareness, but no personal connection*; *I did not care/like*; and *Self-identified "city kid"*.

Nine interview participants indicated that they had a *strong pre-existing connection to nature*, that it was something they cared deeply about, and/or they spent time directly engaging in nature-based activities. Included in this group were participants who had spent childhood years living in rural settings as well as those who had grown up in a highly urbanized setting.

> So before OASP, I did spend a lot of time outside. I, we, as a family, we'd go hiking to Kenneth Hahn [State Recreation Area].... But also, I don't know, I guess in my backyard, since I have a nice big spacious backyard, um, my brother used to go around looking for like arachnids, insects, everything....

In contrast to the above group were six interview participants in the *Awareness, but no personal connection* profile. These participants indicated that they and/or their family were environmentally aware to some degree, engaging in activities like recycling at home and/or some

outdoor recreation activities, but that the participants themselves did not have a strong interest in nature prior to participating in the program. “I was super not an outdoorsy person,” explained one participant, “Like the first, like, [program] bootcamp, I was, like, what did I sign up for? This is a lot of outdoors in nature.”

Three participants expressed disinterest in nature prior to the program - that going outside was a “waste of energy” or that they “didn't really like nature”. These individuals were classified in the *I did not care/like* profile. Two participants were classified in the *Self-identified "city kid"* profile, and they used language that implied that a disconnect from nature was inherent in that identity: “And just being a city kid, like, it was like, what bugs, what dirt? No.”

Following Program Participation, in What Ways Do Students View Themselves in Relation to Nature?

Both the survey and interview data sets suggest that participation in the program resulted in stronger connection to nature for participants. Survey data helped to provide a broad-strokes picture of nature-relevant outcomes for students. Almost all survey respondents agreed that they had formed a stronger connection to nature, grew more comfortable being outdoors, came to better understand and connect to local nature, and grew to better understand their own morals and values as they related to nature (Figure 3). They found nature to be a source of inspiration (63% frequently, 23% sometimes). Almost all respondents indicated that they believed their knowledge of plants and wildlife had increased (71% greatly increased, 20% increased) as well as their understanding of environmental issues increased through program participation (60% greatly increased, 30% increased).

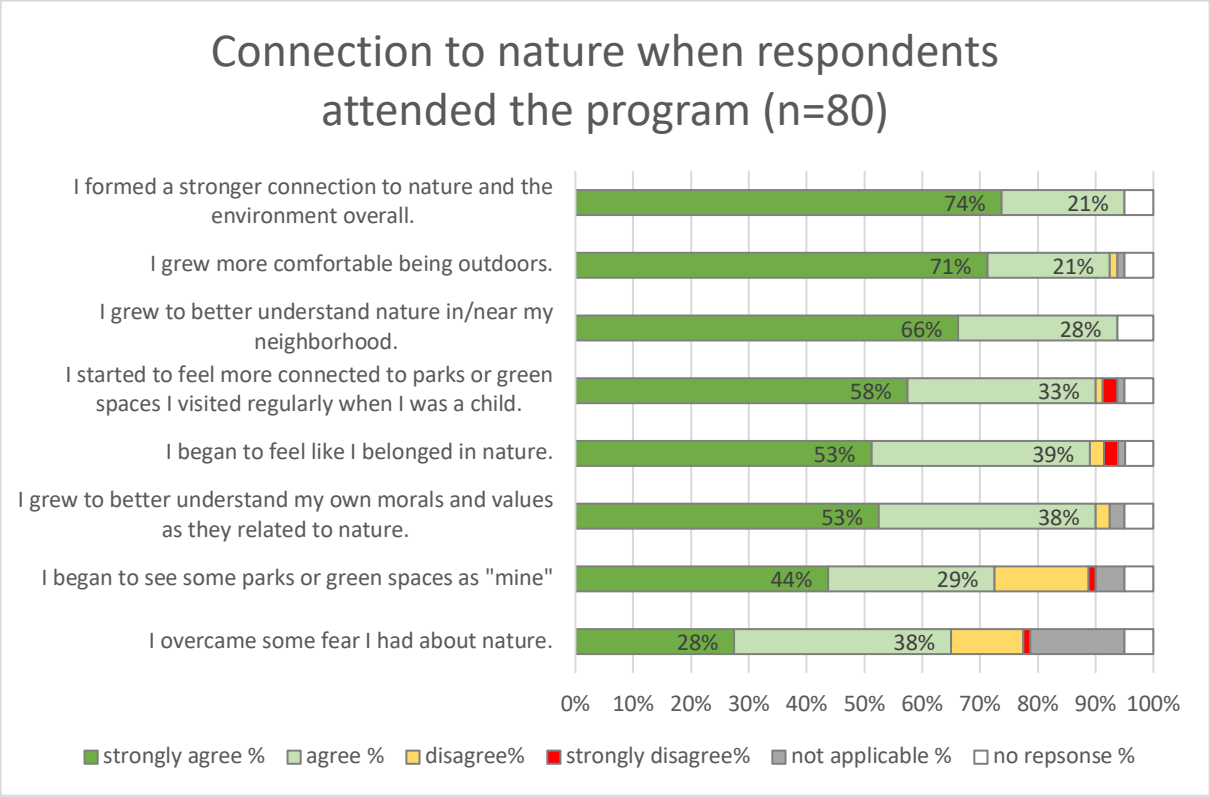

Figure 3. Survey responses to questions about connection to nature when participants attended the program.

Among interview participants, 15 indicated that they developed a stronger connection to nature through the program. This was an outcome experienced by participants across all four of the profiles of nature relationship prior to the program, not just those in the *Strong pre-existing connection to nature* profile. In the paragraphs that follow, I describe participants' beliefs about nature and their nature-based practices.

Nature beliefs/feelings. All but two of the interview participants indicated that program participation influenced their beliefs and feelings about nature. Four themes emerged - *New Awareness or Appreciation, Mental Health/Well-Being, Clarify Existing Values/Feelings,* and *I Like Outside Now* – with participants sometimes expressing a combination of beliefs.

Twenty interview participants described gaining a *new awareness of and/or appreciation for nature*, that they "became more conscious of it and then came to value it more." This was the case even for those participants who already had a strong relationship to nature prior to program participation, with one participant explaining how he developed "another sense of awareness of the, like I said, the wildlife around me... Just kind of a curiosity, I guess, that most people might not have."

Study participants drew a connection between time spent in nature and the *mental health/well-being* of themselves and/or the community. Eighty percent of survey participants said they frequently believed that access to nature can support health, and ten interview participants articulated that perspective as well. "I did not express my emotions a lot before OASP," one participant explained. But, through participation in program activities, he described coming to the realization that "there's a lot of beneficial things going outside, like, you know, to elevate your mood and stuff like that." Other interview participants took a more community-centered view of nature and mental health. The lack of greenspace in her urbanized landscape, explained one participant, "affects even the wildlife, you know, um, and also affects us our health, like our, now that, you know, mental health, you know, that's something that's huge."

For four of the interview participants who had a strong pre-existing nature relationship, program participation helped them to *clarify existing values and feelings* about nature.

> And I feel like, I wouldn't to say like my morals or values really changed after I was in OASP, they like more kind of like solidified and became more pronounced and more defined for me. And 'cause I feel like I had those had those values and stuff before. I just didn't really have like an outlet or way to really, really explain or delve into it. (AA10)

Four interview participants indicated a shift in personal preference for being outdoors that was distinct enough from awareness or appreciation that it merited being its own theme - *I Like Outside Now*. This view was typically stated simply: “I think going outside is kind of fun now.”

Thus, interview data demonstrated that while almost all of the participants indicated that they came to have a new awareness of or appreciation for nature, it also demonstrated that they developed nature beliefs that encompassed connections to individual and community health, clarification of personal values, and shifts in what they find enjoyable.

Nature practices. In addition to nature beliefs, this study also aimed to better understand participants’ nature practices following program participation. The vast majority of survey respondents, and all but one interview participant, indicated that they engaged in nature practices of some kind. I categorized nature practices into two broad categories, indirect engagement and outside engagement. Indirect nature-based engagement included practices that could be done without going outside or interacting with plants or wildlife. Conversely, outside nature-based engagement included practices done outdoors or by interacting directly with plants or animals. Survey questions were constructed along this indirect/outside delineation of nature practices (Figure 4), and my coding process was also informed by this delineation.

Indirect engagement. One of the goals of looking at indirect nature-based practices is to better understand how students connect to nature in highly urbanized environments, places where access to greenspace is not equitable. For example, the majority of survey respondents indicated that they like to work near a window with a view of the outdoors (Figure 4). Examining indirect nature practices also captured socially oriented and knowledge-seeking behaviors centered on nature. These indirect practices are characterized as not necessarily requiring participants to be outside to conduct them. The majority of survey respondents indicated that they engaged in at

least one indirect nature practice (Figure 4), as did seventeen interview participants. From the interview data, I identified four indirect nature engagement practices: sharing knowledge, encouraging others to engage in outdoor activities, community-building, and knowledge-seeking.

The practice of sharing knowledge with others was the most prevalent indirect nature practice among both survey respondents (Figure 6) and interview participants. Sixteen interview participants described ways they shared knowledge, which extended to family members, friends, and the broader community, sometimes concurrently. Knowledge-sharing was intergenerational, directed at parents, nieces, nephews, as well as siblings and peers. It was informal, with interview participants describing their knowledge as a "conversation starter" or "fun fact" that recipients might absorb "through osmosis."

> I think my friends picked up on really weird knowledge that I wasn't intending, and they weren't really intending to pick up on. Um, I know my best friend in high school would always be like, "Why do I know that that's a toyon?" And I'd be like, because I tell you every time we pass it. And I tell you weird things about, like, knowledge that I've learned.

Another social form of an indirect nature practice was the act of encouraging others to engage in outdoor activities, typically oriented toward friends and family members. The majority of survey respondents reported that they encourage friends and family members to do outdoor activities (Figure 4). Seven interview participants described doing so as well. "I would just tell him, like, let's go outside and hang out," explained one interview participant. "Like, let's not be inside, like in the mall or stuff. Let's go to the park, let's go, like, to the beach or stuff like that." Other interview participants described more targeted types of encouragement, such as efforts to recruit friends and siblings to join the focal program or to involve friends and family in outdoor

recreation activities in nature spaces. A participant described how “like a lot of places we would go [in the program], I would recommend them to my family.” After visiting through the program, he took his family to the Angeles National Forest, “and they're like, this is one of the best places I've been to. Like, they've never been to a place like this before.” This was mirrored in survey data, where 63% of respondents reported using their program experience as a way to check out a nature area that they could then take family and friends later.

One interview participant articulated the way these socially oriented indirect nature practices overlap in her life, providing the sole example of community-building around engagement with nature. She explained how friends and family members connected to the program, some of whom are staff, serve as “mentors” as she strives to enter a career in the science community. But, these friends and family members are also a social group who can “geek out together” beyond the program.

> Um, but I feel like it's just nice to think that even outside of OASP, we just plan our own hiking trips, and you know, we still look at birds, we still look at plants.... So, I feel like we influence each other on like different little aspects. Like, I'm the spider woman. My sister is the plant/mushroom person. EC’s like, you know, she has more knowledge on birds. I have, you know, the knowledge I've gained so far at, you know, OASP, LANPO. So I feel like we influence each other, and it's not just like me, because like I said, they're all already nature nerds.

The examples above do contain moments in the outdoors, moments when participants were successful in their encouragement efforts. However, what is indirect about the practices of knowledge-sharing and encouraging others, and even community-building, is that they do not have to be conducted outdoors, nor do participants’ efforts have to be successful for it to count as

a practice. Both knowledge-sharing and encouraging others will be further discussed in a later section of this chapter addressing environmental problem-solving.

Two interview participants provided examples of another indirect nature practice, knowledge-seeking. The act of knowledge-seeking may or may not be inspired by an outdoor encounter with nature. But, the act does require follow-up, the motivation to do additional work to "figure it out," as interview participants described. "Uh, I think I do a little bit more research when I, when I see, um, like insects or animals, than I would have, if I ever was never, like, a part of OASP," explained one participant. In the event that "I find a cool looking spider," explained another participant, "I have, like, my spider books and everything. I'm like, okay, you're gonna look, you're gonna figure it out." Knowledge-seeking is predicated on an interest in learning more about something, an inclination that was also reflected in survey data. The majority of survey respondents reported that they frequently or sometimes like identifying plants and wildlife they see and learning about how other cultures engage with nature (Figure 4). Survey respondents also indicated that they were consumers of nature-related media, and to a lesser extent some respondents also used nature apps for their phones (Figure 4).

Outside engagement. The majority of survey respondents and interview participants reported engaging in one or more types of outside nature-based practices, those conducted outside and/or by interacting directly with plants or animals. These activities ranged from active outdoor recreation in public spaces to gardening to simply opting to do an activity in an outdoor setting rather than an indoor setting.

Outdoor recreation practices were well represented in both survey data and interview data. These practices included a broad range of activities: taking "nature breaks" during the day to refresh, visiting parks local and distant, exercising outdoors, hiking, bike rides, and camping

or backpacking. Survey respondents reported visiting local nature spaces much more frequently than they did activities like camping or backpacking (Figure 4), which are highly dependent on access to time, transportation, and equipment.

Sixteen interview participants described nature practices that involved outdoor recreation, some of which predated program participation. For those participants who may have already had a family background that included outdoor recreation, some indicated that their attitudes about those activities changed, the activities became more meaningful in some way, or the frequency of the activities increased after participating in the program. “Oh yeah. Hiking,” stated one participant, “I actually started going hiking with my family afterwards. So, like, that's kind of crazy.” During these family hikes, she also described being more aware of the native plants species she was seeing, based on knowledge she had gained in the program. Other participants indicated that program participation had influenced them to develop outdoor recreation practices. “Yeah, so during the time of when I was vol-, like during the internship and afterwards, I feel like I kind of had developed this habit of like, just walking outside, um, around my neighborhood just to, you know, get fresh air,” stated one participant. And, despite the prevalence of car transportation, he explained that “I kind of prefer just to walk and kind of like to get active.”

Study participants directly engaged with nature in spaces, such as home and school, in which they were already present for other primary reasons. Growing plants and eating meals outdoors were practices that over half of survey respondents reported engaging in (Figure 4). Nature at home, a common theme among 12 interview participants, was a space where nature practices and stewardship sometimes overlapped, and where program participation changed the way that participants viewed at-home nature spaces. Describing her interest in gardening, one participant explained that “before, that was kind of just, like, something I would let my stepdad

do, but now it's something that I'm also really involved in." Another participant explained how program participation and access to binoculars fostered a new interest in backyard birds, and that she did not think she "would have, like, spent that much time outside, like even my backyard, um, if it weren't for OASP."

Five interview participants discussed their school campus, or spaces adjacent to campus, as places to connect with nature. One participant, describing her relationship with the outdoor spaces on her high school campus, said she became "more in tune as to like, see, Oh, where is there a little space? Or like somewhere where I could, you know, just hang out, but it's nature. It's not, you know, cement, or it's not like a sidewalk, but it's actually, you know, filled with, with like green space, you know?" Similar to at-home nature described above, some participants linked program participation to changes in how they viewed and used outdoor campus spaces. "The fact that, like, you work outside" in the program for all activities was what made one participant realize she could use outdoor spaces for what she had previously thought of as indoor work. "And now I, there's like a bench next to the administration building here, and I, I do all my philosophy homework there, and I go outside, and I work on my computer there..." For two participants, outside nature practice at school also extended to their pursuit of higher education coursework that would allow them to be outside doing field work or a choice of major that they believed was nature-oriented.

I observed considerable overlap between outside nature practices and stewardship activities, as five interview participants discussed how they engaged with nature outdoors while in service to the community. Actions like this will be discussed in greater detail later in the chapter. However, six participants presented a stewardship-like behavior that was distinct from community service, which I coded "active caring". These six participants described nature

practices where they engaged with living things in a way that indicated connection, compassion, or empathy; a kind of an unintentional stewardship or a stewardship decoupled from problem-solving. These included activities like keeping a cat indoors so that it does not chase birds, talking to animals at the park, or not stepping on plants in nature spaces. An excellent example of this type of active caring was one participant's description of her post-program relationship to invertebrates. She is "not so quick to kill bugs," and indoors "I let, um, certain insects live with me" and takes the time to relocate those she does not want indoors.

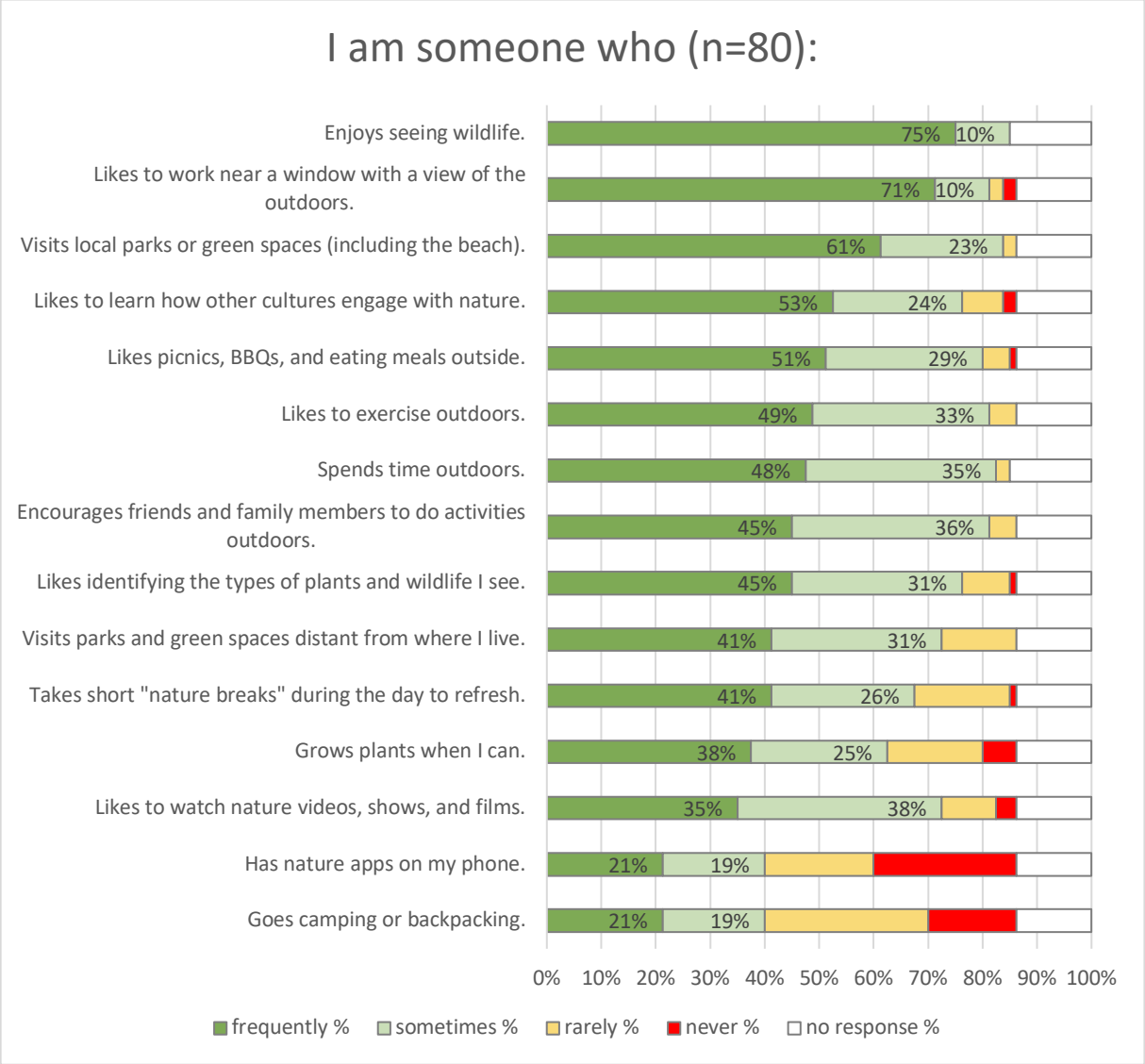

Figure 4. Survey respondents' nature practices, listed in order of reported frequency.

How Do Key Program Elements Influence Students' Relationship to Nature?

As described in the preceding section, both the survey and interview data sets suggest that participation in the program resulted in stronger connection to nature for study participants. Program participation influenced beliefs and feeling about nature, and participants engaged in a range of nature practices. But, how did key program elements influence students' relationship to nature? In this section I use interview data to examine the activities at work within and among Key Elements that may influence students' relationship to nature.

During the coding process, I looked for intersections where quotes coded for key program elements were also coded for nature connection. Not all interviews contained these intersections of codes. However, five Key Elements intersected with nature connection for three or more of the interviews: *Spending Time Outside* (6 interview participants), *Visiting Places that Were New to You* (5), *Doing hands-on work* (4), *Learning about nature* (3), and *Being Social with Peers* (3). Additionally, I noted the specific program activity, if described, within these intersections. Because a program activity might engage concurrently more than one key program element, some activities were present more than once. Overall, activities influencing students' relationship to nature could largely be characterized as those that allowed participants to experience nature first-hand through direct interaction, be a witness to nature, and gain nature knowledge in an outdoor setting with peers. Interview participants cited activities like habitat restoration, data collection in the field, and learning how to conduct indoor activities (like working on a computer) in an outdoor setting as ways that they directly interacted with the outdoor environment in the program.

> Um, I think that's the first thought I think about is the, um, actual manual labor. Because it wasn't something I was used to because I'm a city kid. So, like, to be actually able to, like, you know, you still get dirty playing outside, but you don't really, we don't really get to like play in real dirt, like, you know? And so, like, that was something that was really big for me. Um, to actually interact with my environment.

Interview participants also indicated that opportunities to be a witness to nature – seeing local species, seeing local habitats different that the program's usual location and how they have been impacted by human activity – influenced their relationship to nature. One participant explained how a trip to the Least Tern Colony at Venice Beach helped develop his values and morals around nature.

> I feel like it put myself more in perspective of how, like how, um, various animal species habitats have been, like, damaged in some sorts, and how they've been affected. And, but also giving me some sort of, um, hope that there's ways to help whatever wildlife we can right now, maybe some that we weren't able to before, and some that are a little bit far gone. But there's still some that are here that we can help and do our part to, um, better their habitats....

In this same vein of being a witness to nature, another participant also discussed how his weekly commute from school to the program's park site became a part of the program experience for him, linked to the enjoyment of seeing seasonal change in a nature space, such as "when it was spring, you get to see the, the yellow sunflowers that are growing, seeing bees." Being outside was linked to interview participants' discussion about enjoyment, de-stressing, freedom, mental health, and relaxation.

Gaining nature knowledge in an outdoor setting also influenced students' relationship to nature, including activities like providing knowledge about the big-picture combined with experiences in nature, nature walks, and interactive workshops with hands-on features. One participant described how "OASP consistently pointed out parts of nature...like not just one thing in the environment, but taking, looking at the whole picture and how it sort of interacted with each other." But, what drew her "into the environment more" was "whole picture" learning combined with "actually going out and watching the birds."

Underpinning the nature experiences described above was the fact that these were nature experiences shared collectively with peers. Thus, the Key Element of *Being social with peers* and program activities that created socially shared nature experiences may also be activities that influence students' relationship with nature.

> I know when we were cutting pampas grass, you would try and hang out with your friends. So, it would like, it was an activity that you could do with friends. Everything. I don't know. It was, all of it was about bonding. I don't know if, because I'm thinking back about it. I don't think na-, though nature was central to us, I don't know if we were paying much attention as to what exactly we were doing. We know it was new, it was fun, but I don't, I don't think I was conscious of it at all. I knew it was an activity and we all enjoyed being outside and it was fun.

The importance of the social component of the program is substantiated by the fact that the overwhelming majority of survey respondents reported that they formed friendships with people in the program (58% strongly agreed, 33% agreed), and several interview participants stated that a motivation to join the program was to be with friends. Interviews were the primary source for describing the above activities that influence students' relationship to nature.

However, one of the survey free-responses succinctly encapsulated how program activities that put first-hand experience with nature in a social context influenced the respondent's relationship to nature.

> I also thought just talking with my fellow interns or restoration leaders about the program and otherwise, the social element, was really meaningful because I began to associate spending time in nature with friends and people that I like, which would only make me want to spend more time in nature.

To summarize, students arrive at the program with very different pre-existing relationships to nature, but almost all develop a stronger, nuanced relationship with nature following program participation. They gain a greater awareness and appreciation for nature; some associate nature with wellness; some clarify their own values about nature; and most participants come to believe that they belong in nature. They participate in a range of nature-based practices at home, school, and in community greenspaces. Some of their nature practices are social, engaging friends, family, and community members in the sharing of nature knowledge and pushing them to spend time outside. Learning about nature is important to them. Finally, Five Key Elements were most closely associated with nature connection: *Spending Time Outside*, *Visiting Places that Were New to You*, *Doing hands-on work, Learning about nature,* and *Being Social with Peers.* Activities influencing students' relationship to nature were those that allowed participants to experience nature first-hand through direct interaction, be a witness to nature, and gain nature knowledge in an outdoor setting with peers.

Problem-Solver Positioning within the Program and Participants' Sense of Empowerment

The broad guiding question informing this section was how do key program elements influence students' sense of empowerment to address environmental problems? I first describe

the value that study participants ascribed to the work they did in the program, establishing that they do believe their work matters. I then examine participant perceptions of the skills, knowledge, and attitudes – problem-solver "ingredients" - that position them to be problem-solvers during their time in the program. Next, I articulate the ways that participants felt a sense of empowerment and describe how key program elements influenced that sense of empowerment.

Participants Believe That Their Work in the Program Matters

To provide a context for understanding how Key Elements may influence students' sense of empowerment, I wanted to first understand students' perception of the value of the work they did in the program. Most survey respondents agreed with the statement, *I felt like the work I did mattered* (74% strongly agree, 18% agree). All but one of the 23 interview participants provided evidence for the belief that the work they did in the program did have value – for themselves and beyond themselves. Twenty interview participants were directly asked if they felt that the work they did in the program was important or had lasting value, and all indicated that they believed that it did. Four types of value emerged from interviews, and sixteen participants cited more than one type of value.

Ten interview participants believed that the work they did had value because it contributed to their personal growth. "Look at me now," said one interview participant, "I'm doing urban regional planning with an emphasis in, you know, sustainability and the environment." Six participants believed that the work they did, in particular the research projects, had value because it may contribute new knowledge that others may be able to use. One interview participant described that work as adding a "lego" to something that will continue to be worked on by others.

The two most prevalent types of value that participants ascribed to their work in the program were having a direct impact on environment and having social/community value, each cited by 15 interview participants. Interview participants cited their efforts in habitat restoration on parklands, in particular, as important and having lasting value. One participant exemplified this line of thought. Reflecting on his observation of a bird at the park foraging in native habitat, he explained that "the work we do is definitely important because it's not only important to, like, it's not only beneficial to humans, but to like the native environment there, because it relies on it. And if we don't do it, like no one else is going to do it."

Through their role in the community as a "carrier of information", being a visible presence on public lands, and/or through their collaborative work with one another, over half of interview participants believed the work they did had a social/community value. "I think when people see the students at OASP working, it sends a good message that this community is here to help," explained one participant, "and it's here to kind of upbring everyone or bring everyone up."

Though sense of empowerment will be discussed in greater detail later in the chapter, I did observe some intersection between quotes coded for empowerment and quotes coded for value. This is encapsulated well by one interview participant when she described her work as "instrumental" in both protecting nature spaces and teaching communities about those spaces. "And the fact that, um, you know, I, I felt like I'm not just a student at Dorsey High School, but I'm also, you know, if, I don't know if, I guess this is a right way to say, but I'm also like an environmental steward," she explained. "I was kind of like a protector of those spaces, but at the same time, you know, um, someone who was there to teach and hopefully even, you know, influence in a way, um, to think differently about how to use those spaces."

Problem-Solver Positioning within the Program

To better understand how program elements might influence participants' a sense of empowerment to address environmental problems, I next examined what participants believed they had gained from the program. In particular, did they gain knowledge, skills, and attitudes that could position them to be environmental problem-solvers?

The survey protocol was designed in part to capture respondents' beliefs about the skills, knowledge, and experience they gained through program participation. A series of questions asked respondents to assess their learning gains broadly as well as in specific topics and skill sets. Almost all respondents believed that they had gained new skills and knowledge (85% strongly agree, 8% agree), and most also believed that they had learned things about themselves (50% strongly agree, 43% agree). In terms of leadership, respondents believed that they saw ways that they could teach other people (60% strongly agree, 31% agree), learned that there are different ways to be a leader (54% strongly agree, 35% agree), and had the opportunity to be a leader while in the program (51% strongly agree, 36% agree). Respondents believed that they came to better understand their own morals and values as they related to nature (53% strongly agree, 38% agree) as well as family and community (48% strongly agree, 39% agree).

The more specific knowledge topics and skills areas presented on the survey represent a range of competencies that could position a student to be an environmental problem-solver. The majority of respondents reported that their knowledge, understanding, or skill level in each area had increased by attending the program. Of the five areas of knowledge, the topic of plants and wildlife ranked highest, with over 70% of respondents reporting that their knowledge had greatly increased. The other four knowledge topics all saw well over half of respondents report that their knowledge had increased as well: understanding how different issues might actually be

connected (60% greatly increased, 28% increased), environmental issues (60% greatly increased, 30% increased), the process of doing science (51% greatly increased, 26% increased), and community issues (44% greatly increased, 39% increased). Thirteen skills areas were presented on the survey, all of which had greater than 50% of respondents reporting some increase in their skill level (Figure 5). In particular, collecting data, using data to support an idea, outdoor skills, and observational skills ranked the highest.

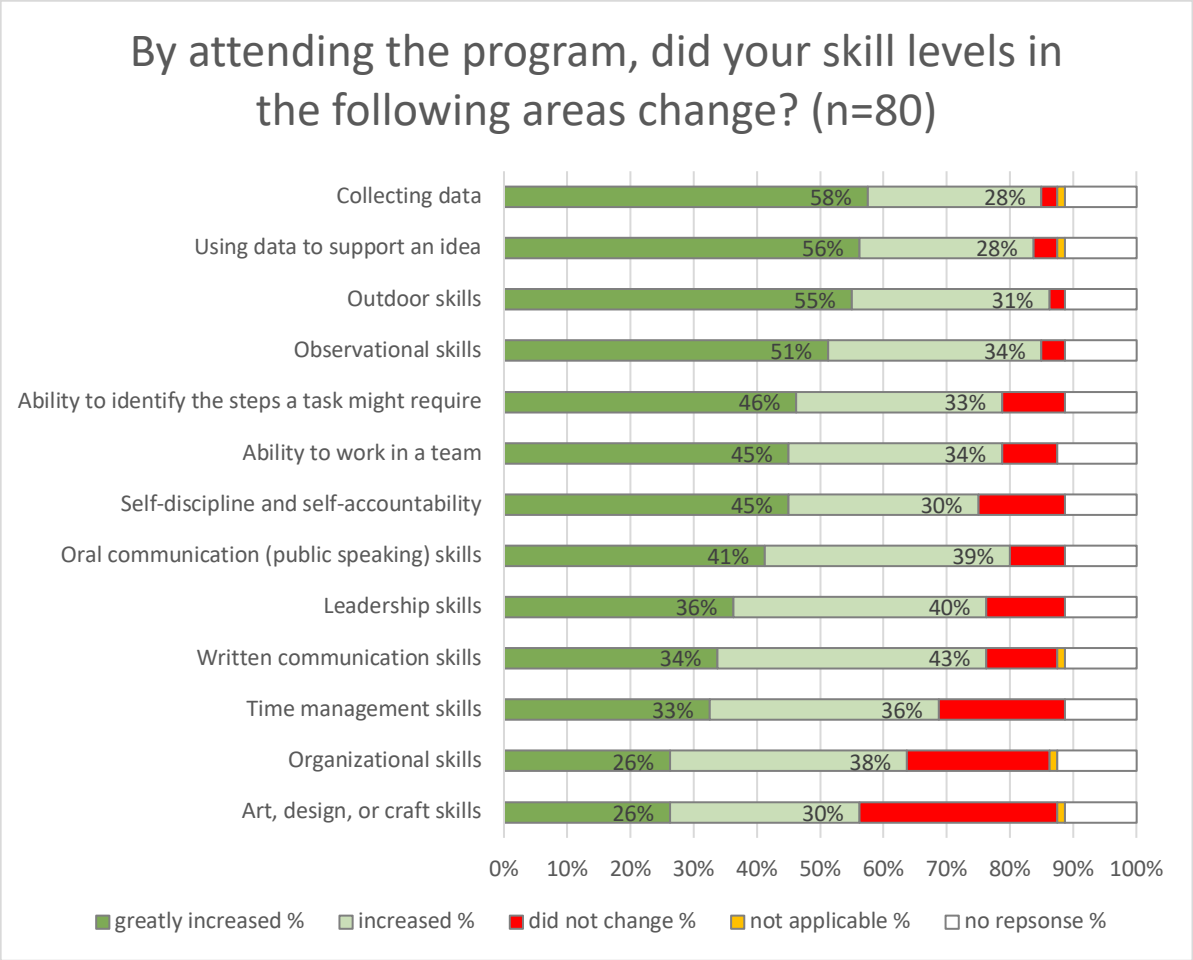

Figure 5. Survey respondents reported increases in a range of skills areas.

Overall, survey data indicated that program participants, by their own assessment, gained knowledge and skills that could position them to be environmental problem-solvers. A similar pattern was also observed in the interview data. Using the concept of environmental problem-

solving as a lens, I created a coding framework for interview data that addressed the "ingredients" (skills, knowledge, and attitudes) a student would need to position themselves as a problem-solver. This was largely drawn from the interview questions that asked participants how they felt they had benefited from the program, their way of thinking compared to non-program participants, how the program made them feel about being a community member, and how they felt the program had prepared them to address environmental problems. I identified seven Problem-Solving Ingredient (PSI) categories (Table 6).

Table 6. *Problem-solving Ingredients (PSIs) identified in interview data.*

Problem-Solving Ingredient (PSI)	**Description**	**No. of participants who cited this PSI**
Background Knowledge	Knowledge gained about environmental issues, plants and wildlife, community issues	19
Framing the Problem	Skills gained such as collecting data, thinking about the steps required, seeing connections, thinking more deeply about a topic, being open to new ways of thinking, curiosity	19
Self-skills	Skills gained in observing, being organized, self-disciplined, time management, stress management, stepping out of personal comfort zone, developing personal values	14
Connection to Community	Expressions of being aware that a community exists, feeling part of a community, sense of responsibility towards community	15
Collaboration	Skills gained in teamwork and leadership practices, working with new people	14
Communication	Skills gained in oral, written, and visual communication	15
Career Direction	Expression of feeling that a specific career or higher education path could be a context for making a difference in the world, and/or forming a connection with program staff who could help them with that process	7

All 23 interview participants indicated that they had gained more than one PSI through the program. To examine how the program influenced the development of PSIs, I looked for

intersection between quotes coded for PSIs and quotes coded for key elements. While these intersections were not represented in every interview, each of the 11 Key Elements did intersect with at least one PSI for at least one interview participant. I also looked for references that participants made to specific program activities that they linked to their development of PSIs. In the paragraphs below, I describe each PSI and associated Key Elements and activities in greater detail.

Background knowledge. This PSI category found the greatest intersection with the Key Elements of Learning about nature (intersections in 5 interviews), Doing hands-on work (3), and Visiting places that were new to me (3). Though, Being social with peers, Working as a team, Teaching others, and Networking/access to other opportunities, each had one intersection as well with this PSI. Learning about local nature – a type of knowledge participants described as distinct from what is presented at school - and linking knowledge directly to a hands-on activity with observable phenomena were primary activities described by participants. “Um, but I think of it in the sense of like, I get hands on experience,” said one participant, “but I'm also learning about my local ecology.” Another participant said he found it helpful the way the program linked environmental issues to the level of the local community, “like with the Ballona Creek, for example, or, um, it's like the Ballona Watershed and how that's very important to, uh, sort of city of Los Angeles, um, and how that's kind of been disrupted by, by human activity.” Another participant explained why she found a soil sampling lesson an important learning activity. She explained that “dirt is not just dirt, you know?” and learning about soil “takes it back to basics, because something as simple as dirt still has, you know, different considerations and stuff like that, especially since we are the ones who thrive on it the most, who were living on it.”

Framing the problem. This PSI category found the most intersection with Doing hands-on work (intersections in 5 interviews), Learning about nature (3), and Visiting places that were new to me (2). Safe Space/Emotional Support/Caring Staff, Teaching others, and Spending time outside each had one intersection with this PSI as well. Several activities were suggested, including those that provided an opportunity to wonder and pose questions (e.g. daily notebook prompts, field notebooks), informal conversations with staff, a range of source materials that connect nature knowledge with community issues, linking knowledge directly to a hands-on activity with observable phenomena, and engaging in the entire process of a research project. One participant described the program as a "different mental environment." Through the reading and writing required to do her research project, she explained that "you think on a different level, like on different perspective, because you have to think critically and you have to think analytically and you have to think differently than you would like in school," and that the program "helped me develop the way that I think." Others described the program as a place where "we take like a very like deep look, as nothing, nothing's like black and white," and where participants might begin to understand "the political effect that nature had, how nature could be political." Citing the problem of plastic waste as an example, another participant described how her awareness of complexity changed, stating that "every single issue in the environment has like different like components and you have to consider all of them."

Self-skills. This category found intersection with Spending time outside (intersections in 3 interviews), Visiting places new to me (3), and Doing Hands-on work (2). Teaching others, Being social with peers, and Communication/Public Speaking also each had one intersection with this PSI. A range of distinct activities were suggested for how students developed this PSI: that the program provided structured time for nature-based activities in students' lives, time

outside helped with stress management; the application process itself was an important entry point to learning how to take something seriously; activities like icebreaker games and teaching opportunities that pushed students out of their personal comfort zone; seeing how habitats have been affected; and interacting with a diverse peer group. One participant provided a clear example of the organizational skills he had gained through the program, explaining, “I feel like you need to prove, like, have a clear vision of what you want to do. It might not be clear at first. Um, but it definitely like helps to, like, write down your goals and kind of get precise about what you want to do.” Another participant described how social interaction within the program helped him develop *Self-skills*. “I think the thing about OASP, I think, that, that helped me get to know myself better was the fact that I wasn't the only one that might've been new to, to, to that,” he explained. It was also “the fact that there were different community members there that I wouldn't have otherwise interacted with, the fact that we were all among the same age group,” that he said helped him to know himself better.

Connection to community. This PSI category found intersection with Working in the community (intersections in 3 interviews), Teaching others (2), and Being social with peers (2). Doing hands-on work and Communication/ Public Speaking each had one intersection for this PSI. Activities were primarily community-focused and included getting a range of source materials that connect nature knowledge with community issues, having work that is visible within a community space (e.g., habitat restoration), opportunities to directly engage with community members (e.g., teaching younger students, doing public presentations), and opportunities to work in communities outside the students' own community. Multiple participants described the importance of working in a community outside their own, “being able to see experiences of someone else,” and “just telling the adults around me, Hey, after school, on

this day, I won't be nowhere around, you know, Dorsey, I'll actually be somewhere across town, you know, teaching younger students about what I'm learning at, you know, OASP." Others described a new awareness of being part of a community. One participant began to "like the idea a little bit more better about being a community member," and wanted to "to help support the people around me and whatnot, and make sure that they're okay." Another participant, describing the awareness she gained about issues affecting her immediate community, in particular food deserts and lack of access to nature space, said, "It made me aware of everything that was going on in the community, the injustices that were, were prevalent there and that, it made you want to do something about it."

Collaboration. This category found the greatest intersection with Teaching others (intersections in 7 interviews) and Working as team (5). However, nine other key elements also had intersection with this PSI in 1-2 interviews each: Networking/connection to other opportunities, Safe space/emotional support/caring staff, Visiting places that were new to me, Working in the community, Communication/public speaking, Being social with peers, Doing hands-on work, Learning about nature, and Spending time outside. Activities were socially focused, and interacting with a diverse set of peers was cited again. Other activities included that the program's location served as common ground, opportunities that put students in the role of mentors/teachers to younger students, observing how older peers behaved, getting feedback from peers on in-progress work, and opportunities for teams to manage themselves to achieve a task without direct staff input. One participant cited the opportunity to "draw from other people's sources of knowledge" in the process of completing a project. Multiple participants described the importance of teams being required to self-organize. "We're just like, okay, let's support each other," described a participant, "I think that's what helped instead of there just being one person

in charge...” Another participant explained that “It's kind of like you get that experience of helping yourself, organize yourself and organize others to work together towards something” when there were tasks to complete without “a staff member telling you what to do necessarily.”

Communication. This PSI category found intersection with Communication/Public Speaking (intersections in 3 interviews) and Teaching others (2). Working as a team and Doing hands-on work each had one intersection with this PSI. Activities cited were largely those targeting specific communication skills, such as training in public speaking techniques and games involving communication, opportunities to present work publicly, creating hand-written posters in teams, other opportunities to collaborate with peers, developing and implementing lesson plans for younger students, and writing instruction as part of doing a research project. The blend of formal and informal presentation activities, “like the elevator speeches and then also just talking with other people and working together with other people,” were credited with helping participants gain communication skills. One participant, now a middle-school classroom teacher, framed the process of collaborating and teaching others as ways that a range of communication skills were developed in the program. She described learning “ways of differentiating our instruction” that allowed team members to capitalize on their individual strengths, such as drawing or humor, when it came time to teach younger students.

Career direction. This PSI category was the least represented in interviews among the seven PSIs. There were few overall intersections with Key Elements, and they occurred with Teaching others (intersections in 2 interviews), Visiting places new to me (1), Networking/connection to other opportunities (1), and Working in the community (1). Activities largely followed two tracks, having the opportunity to teach while still a high school student and seeing how habitats have been affected. Overall, the representative sentiment was, “Just the

program really helped me a lot in deciding what I wanted to do in my career, surprisingly." However, one participant clearly articulated how a beach ecology trip through the program made her realize that she was "destined to be some sort of educator" and set her on a career path in STEM education. "Um, it was like a triggering activity because that's when I realized the large impact that humanity has on not just the planet, but all the organisms around us and how our world function... Like, I want to teach people about like all this interconnectivity of our world and our ecology and our environment."

To summarize, all 11 key elements were represented in at least two PSI categories. However, five key elements were represented in over half of the seven PSI categories: Teaching others (all 7 PSI categories), Doing hands-on work (6), Visiting Places that were new to me (5), Being social with peers (4), and Communication/public speaking (4). Key Elements themselves can often have extensive overlap within a program activity. For example, a program activity could involve a team of program participants working together (KE Working as a team) to teach younger students (KE Teaching others) through a hands-on activity (KE Doing hands-on work) in a greenspace that is new to them (KE Spending time outside and KE Visiting places that were new to you). This overlap may explain the broad representation of all elements. But, the prevalence of a subset of the key elements indicates that they may be of particular importance, either singly or in combination with one another. Numerous activities emerged that were linked to each PSI. However, four activities were connected to more than one PSI: Linking knowledge directly to a hands-on activity with observable phenomena, providing a range of source materials that connected nature knowledge with community issues, interacting with a diverse peer group, and seeing how habitats have been affected.

How Does the Program Influence Participants' Sense of Empowerment?

As described above, participants believed that their work in the program had value beyond just being a benefit to themselves, and they also believed that they were able to build competence in areas that position them as problem-solvers during their time in the program. But, did they also gain a sense of empowerment to be environmental problem-solvers? I define "problem-solvers" as individuals who can identify and articulate a problem in their community; possess the motivation to take concrete steps to attempt to address the problem; understand the importance of working collaboratively and know when to seek the expertise of others in areas in which they have limited content knowledge; employ imagination and creativity in developing solutions to the problem; and are resilient to the setbacks inevitable in addressing real-world problems. Because the survey instrument was built with the above problem-solver definition as a guiding framework, survey data were particularly instructive in understanding what participants thought of their own abilities and the amount of power they believed they had to implement change. Interview data then provided nuance in describing sense of empowerment, helping to identify the overlap among empowerment and key elements, and suggesting activities that may influence participants' sense of empowerment.

Survey data indicated an increase in both confidence and willingness to take action. The majority of respondents reported that their confidence to solve problems increased (38% greatly increased, 41% increased) and that they had changed some of their own behaviors to be more environmentally friendly when they were in the program (59% strongly agree, 30% agree). Respondents indicated that when trying to accomplish a goal, they believed they could collaborate with others (58% strongly agree, 28% agree), work on their own (46% strongly agree, 40% agree), and lead a team (41% strongly agree, 40% agree). They believed that they

could recognize when outside expertise might be needed to accomplish a goal (63% strongly agree, 23% agree) while also having the ability to recognize their own strengths (48% strongly agree, 39% agree). Finally, on issues that were important to them, respondents believed that they could express themselves through speaking and/or writing (41% strongly agree, 43% agree).

Survey respondents also reported having attitudes and engaging in behaviors that foster problem-solving. Of the 80 respondents, 76% reported frequently believing that they liked learning new things, that they participate in creative work (51% frequently, 21% sometimes), and that they think about environmental sustainability and ethical production when making purchases (48% frequently, 34% sometimes). Since participating in the program, 73% reported that they frequently notice more about their surroundings and that they feel more comfortable talking to new people (54% frequently, 28% sometimes). Though reported with less frequency, respondents did indicate that they paid more attention to issues in the news (31% frequently, 49% sometimes) following program participation. Specific to problem-solving, respondents reported that since participating in the program, they take time to think about how to approach a problem (63% frequently, 21% sometimes), consider multiple approaches (54% frequently, 28% sometimes), and see how issues connect and overlap (56% frequently, 29% sometimes).

Survey respondents also appear well-positioned to act within their communities. The majority reported that they frequently identify things they would like to change within their community (56% frequently, 24% sometimes). Almost all survey respondents felt like they were part of their community when they attended the program (68% strongly agreed, 24% agreed). However, when the question was framed as *I am someone who feels like I have a place in my community*, responses were less emphatic, but still overall positive (39% frequently, 35% sometimes). Despite some uncertainty about their place, most respondents reported feeling a

sense of responsibility to their community (44% frequently, 36% sometimes). Overall, respondents believed they have power to make a difference in both their community (29% strongly agree, 54% agree) and at the smaller scale of their family as well (39% strongly agree, 40% agree).

Survey data indicate that participants have confidence in their problem-solving abilities and appear well-positioned to act within their communities. To provide nuance in describing participants' sense of empowerment, interview data was essential. This data set also helped to identify the overlap among Empowerment and Key Elements and suggest activities that may influence participants' sense of empowerment.

Eighteen of the 23 interview participants made statements suggesting that they felt a sense of empowerment through program participation. Sense of empowerment was frequently linked to feelings about community, with participants seeing nature and environmental issues as community issues. "Even though a lot of this stuff about community, about community that we learn in OASP is maybe environmental," said one participant, "I feel like it also connected things in other ways too as well..." Another participant expressed feeling a sense "of the responsibility of creating that shared space between urban and nature, like it has to involve the people present in that area because we're the one who's upkeeping and making the decisions for everything."

Sense of empowerment was nuanced among interview participants, and I identified four empowerment categories: *I can do this*, *Pride/Accomplishment, Sense of responsibility*, and *You don't have to wait,* and *Staff influence*. When possible, I attempted to identify the specific program activities that interview participants linked to their sense of empowerment. During the coding process, I looked for intersections where quotes coded for key program elements were also coded for empowerment. Not all interviews contained these intersections of codes.

However, six key program elements intersected with empowerment for one or more of the interviews: Teaching others (8 interview participants), Working in the community (3), Visiting places that were new to you (2), Doing hands-on work (1), Communication/Public Speaking (1), and Safe Space/Emotional Support/ Caring Staff (1).

The *I can do this* empowerment theme was characterized by statements about being capable, feeling less afraid, or having more confidence, and it was present in 12 of the interviews. This empowerment theme had intersections with the key elements Teaching others, Working in the community, and Visiting places that were new to me. Numerous activities emerged from the interviews, including engaging in the research process; having work published; learning from a professional, learning with peers, and learning things not taught in school; working to fix a visible problem at a local park (e.g., trail erosion); participating in a research process similar to that of people with PhDs; interacting with the community to share information; leading younger students on a nature walk at an urban park and being in a teaching/mentorship role to younger students; watching family members act on advice from program participant based on knowledge gained from program. The *I can do* this empowerment category and multiple activities are well articulated by a participant describing how, through learning information not taught in school, "learning it with a group of people and from like a professional that like, knew, actually knew how to do things," he came to view himself as "someone who can, definitely can make a change." He continued, "I feel like I view myself as a contributor. I would label myself as that, um, because I can definitely, like, I still have retained that information that I can teach and apply."

Seven participants expressed a sense of *Pride/Accomplishment* in their work in the focal program. "And I kind of felt, I personally felt proud of that because I would tell my mom and

dad," said one participant, when referring to planting native plants in the park. "Like, I would show them like pictures. I was like, like, we all planted that." This empowerment theme did not have intersections with quotes coded for key elements. Having work published was again cited as an activity within this empowerment theme. Other activities were community and socially oriented, such as planning and implementing an activity for peers, working in public spaces where the student had a pre-existing childhood connection, feeling like part of a community, and doing visible work in a public space with peers. One participant explained how her sense of pride was rooted in having demonstrated a long-term commitment as well as the ability to speak about that commitment. "Um, especially for a lot of us who weren't even 16 when we started, like, that's, that's incredible.... I didn't just do a thing, I can talk about that thing."

Five participants framed empowerment as a *Sense of responsibility* - to community and/or the environment. This empowerment theme intersected with Teaching others, Visiting places new to me, Communication/Public Speaking, and Doing hands-on work. Activities suggested by participants describe bearing witness to community and nature as well as believing that the program has a legacy. One participant told the story of her bus ride home from the program as part of that process of bearing witness. As her bus travelled east away from the park area, she observed "the decline in, in like how much nature was re-, like, retained...it became more, more plastic and concrete and metal than anything else, you know." She explained that witnessing this contrast and reflecting on the lack of exposure to nature she and her immediate community had "propelled me to want to do more."

Cited by three interview participants, the *You don't have to wait* empowerment theme captured a perspective unique to a youth demographic. This idea that "even as a high school student, you do have some agency in what you can do," intersected with the key element of

Teaching others. Activities included teaching younger students within and outside participant's community and doing habitat restoration and research projects. For one participant, now a classroom teacher, the opportunity to teach younger students while in high school was where she "got that sense of empowerment." She stated that if more opportunities like that existed "I think it would just change the way we see the world and also how we fit in it, that we don't have to wait till you're 18, or, you know, after, um, you know, we graduated college or after we, um, go into the workforce to make a change or be essential or, like, instrumental, but we can start even at an early age, earlier than 18."

Only one participant's response was placed in the *Staff influence* category of empowerment, linking the support of staff and access to opportunities to her sense of empowerment. There was intersection between this empowerment category and the key element *Safe Space/ Emotional Support/ Caring Staff*. "I think we sort of learned how to organize, but we had people behind us helping us with organizing," she explained. Later in the interview she described how aspects of her resilience and perseverance were linked to the fact that "I got a lot of yeses, and I saw opportunities line up because you guys present opportunities to us all the time."

In sum, the majority of interview participants expressed a sense of empowerment. Six key elements intersected with sense of empowerment: Teaching others (8 interview participants), Working in the community (3), Visiting places that were new to you (2), Doing hands-on work (1), Communication/public speaking (1), and Safe Space/Emotional Support/ Caring Staff (1). Numerous activities again emerged, most of which centered on doing visible work within community spaces and directly engaging community members through events that allowed participants to share their knowledge. Similar to participants' relationship to nature, the data

suggest that influence on students' sense of empowerment may actually be the result of a combination of key elements applied concurrently in the program.

Program Participants as Environmental Problem-Solvers

In the previous section, I established that participants believed they had gaining a range of skills that could position them to be environmental problem-solvers, demonstrated confidence in their abilities, were well-positioned to act within their communities, and that they felt a sense of empowerment through program participation. Given these favorable factors, do participants actually take action as environmental problem-solvers in their own lives? And if so, in what ways?

Study participants provided unambiguous examples of how they have acted as environmental problem-solvers, as described by the two survey free responses below.

> As a youth I never felt safe using my outdated local parks and as an adult I was able to work with my neighborhood council to update, design, and renovate my local pocket park in Jefferson Park. I enjoy seeing my neighbors make use of it and enjoy time there. I believe the quality influence OASP had in my youth created the full circle I've reached today.

> Being a part of the program help me get into my current job where we recycle hazardous waste. Hazardous waste can be detrimental to the environment and I am happy knowing that what I do is helping hazardous waste from getting into the environment

Study data indicate that participant problem-solving occurred in a range of directions, at different scales, and sometimes without such clear outcomes. In this section, I address the varied ways that participants both view themselves and act as environmental problem-solvers.

Participants reported using their program experience in ways that helped them navigate academic, professional, civic, and personal life. All 23 interview participants described actions taken and/or instances when they applied knowledge or skills that they had learned in the program to other parts of their life in some way, and 84% of survey respondents indicated that they had applied their program knowledge in some way. Some of this knowledge application, while it may have been solving a problem in a participant's life, could not be considered *environmental* problem-solving. For example, fourteen interview participants provided examples of applying the communication or research skills they learned in the program to better accomplish tasks in an academic or work setting, such as completing a research paper, making a connection between class content and information learned in the focal program, public speaking, time management, representing themselves at a job interview, or interacting with coworkers or customers. One participant described applying the skills he had learned in the program to a senior thesis project as a wildlife science major as, "walking in my own playground that I had already been in before, basically."

However, interview data provided greater insight than did survey data into the ways that participants acted as *environmental* problem-solvers. All 23 interview participants indicated that they took action or applied their knowledge/skills in a context that could be considered environmental problem-solving, with 19 indicating more than one type of action or application. Actions ranged from small behavior changes to developing a vision for the future of their community. I classified environmental actions and knowledge/skill application instances into six categories: *Stereotypical environmental activism; Environmental leadership at work or school; Career track choice; Immediate control, Influencing family, friends, and community;* and *In the future.*

Stereotypical Environmental Activism

The category of *Stereotypical environmental activism* focused on actions like signing petitions, donating money, participating in social media, voting, or volunteering in an environmental context – actions that are stereotypically associated with environmental activism and stewardship. Survey respondents did report engaging in these activities but did so at much lower rates of frequency compared to other types of action (Figure 6). Similarly, only seven interview participants discussed ways they engage in stereotypical environmental actions. These actions mainly included joining community service activities focused on environmental stewardship, such caring for a greenspace or community garden. But, interview participants also described work they did for environmental justice. One participant described being, "a little bit more like an advocate more on like social media." Referring specifically to environmental justice issues, such as Indigenous peoples' land rights, she continued, "So if I can just, you know, advocate, like, you know, share their posts, donate, anything like that, you know, it's like things that, like I said, I never thought about before." She was the only interview participant who mentioned donating to a cause. Another participant discussed being an environmentally informed voter, holding politicians accountable, and wanting "to see how they take on, you know, right now the hottest thing is, no pun intended, global warming. So, it's just like, well, what are your views on it? Do you think science is fake or do you actually think global warming is a real issue? We should really tackle that. And how are you tackling that?" This sentiment is substantiated by survey data, where 40% respondents reported that they used their program experience to inform decisions when they vote.

While actions that are stereotypically associated with environmental stewardship and activism were represented in the study population, stereotypical actions were not where participants focused their environmental problem-solving efforts.

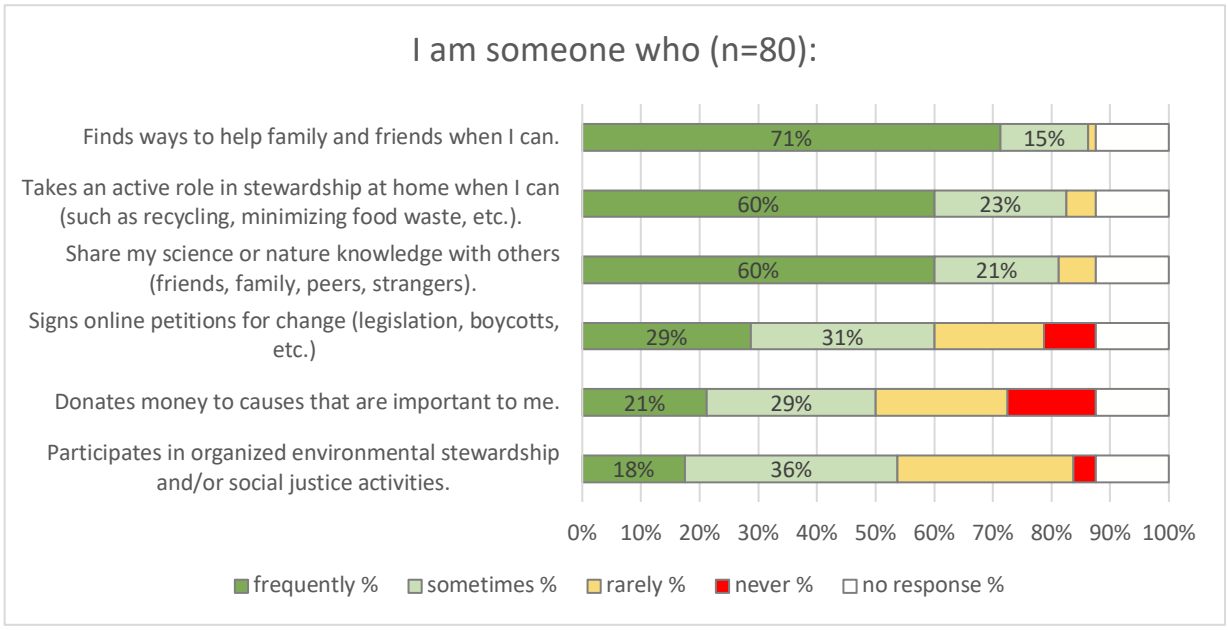

Figure 6. Survey respondents' problem-solver actions.

Environmental Leadership at Work or School

Six participants describe instances of *Environmental leadership at work or school*, taking initiative within a school or work setting as an environmental problem-solver, beyond volunteering for a community service opportunity. One participant described independently picking up trash on campus and engaging custodial staff at his high school in discussions about how he could help maintain the campus, while another participant explained how he used the nature knowledge gained in the focal program to enrich the curriculum he was implementing at his job as an outdoor educator. A third participant described how he applied a habitat restoration technique he learned in the focal program to his professional life in pest control, in an effort to prevent a problem and minimize the need for pest control in the first place. Three participants

discussed how they used formal leadership positions as an opportunity to promote environmental goals within their school or club. One participant described becoming a sustainability representative on her college campus so she could implement sustainability measures in the dorms. Similarly, another participant, student body vice president at his community college, explained how he was collaborating with the eco-club president to provide nature activities for students. President of his school's journalism club, another participant stated that "I think partly because of what we did at OASP, I've been a lot more active in sort of reaching out," and he described a collaborative approach he took to engage "different presidents of, like, environmental clubs at our school" as a way to amplify local environmental issues.

Career Track Choice

Six participants described their *Career track choice* in ways that linked those choices to environmental problem-solving, particularly how they related to community. "Uh, like in the past I was only thinking like, oh public health, but I think I'm trying to go into specifically like mental and like environmental health as well." These participants represented diverse career tracks – public health, journalism, education, urban planning, and biology. For one participant, "it was specifically like OASP was that aha moment for me to want to become an educator" in STEM and wanting to "replicate to the best of my ability, that experience I had, for students." While the *Career track choice* category represented a small subset of the 23 interview participants, it demonstrates a commitment to weaving environmental awareness and action in long-term ways on multiple professional fronts.

Immediate Control

When refocusing to areas of participants' life where they have immediate control of the decisions they make – where they do not need permission to act – we see environmental

problem-solving frequently on a small scale. The *Immediate control* category encompassed examples of participants are taking environmental action in areas of their life where they have the autonomy to do so. All but three interview participants provided examples of these actions, and this was also substantiated by the fact that the majority of survey respondents reported that they take an active role in stewardship activities at home when they can (Figure 6). “I'm like, okay, well, it is this, like, really, this might be, like, short-term more convenient for me, but like, do I really want to, um, use more, I dunno, plastic bags or whatever? Like anything that we discuss, like it pops up in my head and that like influences the dec-, uh, decisions I make.” Interview participants described individual actions, such as avoiding single-use water bottles, being aware of water use, recycling, yard and garden decisions, composting, food choices, mitigating litter, and being mindful about consumption. Some participants articulated how their individual action linked to something specific they had learned in the program. One participant, observing that “a bunch of people walk their dogs and don't pick up their, like, waste” explained that she is committed to doing so because, “you know, think about, like, the impacts it has, like, how we learn about the water when it rains, how everything just goes to the ocean.”

Examples within the *Immediate control* category were often linked to a social aspect: not only do participants act themselves, but they also try to convince others to take that action as well. Survey data provide context for understanding how participants attempted to influence others. The majority of respondents reported that they had tried to change the behavior of friends and family members to be more environmentally friendly (50% strongly agree, 36% agree). They also reported sharing their science or nature knowledge with others and believed that they frequently found ways to help friends and family when they could (Figure 6). Attempting to change behaviors of others and providing knowledge combined with caring or helping sets the

backdrop for the nuanced actions and relationships that emerged in the fifth category of environmental problem-solving, *Influencing family, friends, and community*.

Influencing Family, Friends, and Community

Examples from 19 interview participants comprised the *Influencing* category of actions, describing participants' attempts to influence environmental decision-making and engagement of family members, friends, and people they encountered in the community. This included actions like sharing knowledge, facilitating trips to nature spaces, recruiting new students to the program, and informally providing knowledge to members of the public while at public greenspaces, participating in environmental decision-making at home. In multiple cases, participants described instances where they became environmental leaders within their own families, sharing their knowledge and participating in the decision-making process of family environmental practices, like recycling, sustainability in items purchased, and landscaping. One participant explained how her enthusiasm for what she was learning in the focal program translated into influence in family decision-making.

> And so the fact that I was in OASP at the time that that was happening, you know, it just really, it opened up a lot for them. Um, I think any little bit of information, especially when you in, you know, obviously when you, when you like, and when you enjoy, when you, what you're learning and you bring that back, you know, people are gonna listen. People are gonna, you know, pay attention and see what you have to say. And so, and it did, it changed the way, like our habits.... And, and, um, yeah, it's been, it's been, it's been actually exciting to see that change and how I've been able to kind of, you know, influence them.

Participants described the influence they exert on friends and family to practice good stewardship while visiting nature spaces for recreation. Littering was a repeated topic. “They try to tease me sometimes and be like, here, take this, I know you the, you're the litter police.” Another participant described having a “voice” in his family’s behavior when they visited green spaces, both verbally and through the behavioral example he set, “even if it was the smallest gesture was like, Hey, we gotta clean this up. Or they saw me cleaning up. They realize, okay, yeah, we've got to pick up our stuff. We've come here to have fun. So, we must take care of the environment.”

Participants also provided examples of how their nature knowledge and experience with habitat restoration techniques sometimes made them an authority on those topics, with family members and people within their social circles seeking them out for advice and assistance about gardening and landscaping in particular. One participant described being sought out for advice by a friend who wanted to start a landscaping business. She provided detailed information about native and invasive plants and let him know “that like you can still make a really, an aesthetic landscaping with native species and that, that can be a great point to make to your customers, um, as you are trying to like, clientele, because they're not a lot of people who, who specialize in native species when they are redoing people's yards and things of that nature.” In another case, when a participant became aware that her own knowledge and experience actually exceeded that of her parent, it became a source of family contention. She described “constantly yelling at my dad” and getting “frustrated because he wasn't, um, planting the new plants correctly. Like, they're all getting messed up.”

In the Future

The final action category, *In the future*, emerged in part as an artifact of the pandemic. The interviews were conducted during pandemic closures of schools, workplaces, and public spaces, limiting options for implementing environmental action. Interview participants were experiencing illness, some had to had to relocate away from their established communities, and everyone had to put daily and long-term plans on hold to some degree. The *In the future* category was an attempt to capture anything that participants said about their intent to act in the future that was distinct from the other categories of action. Ten participants provided information for *In the future*, but much of what was expressed was minimal or vague. However, a few outlined specific ideas for future environmental and community action, such as involvement in a community council or a return to an environmental career track, and how to bring STEM and nature opportunities to students.

"Um, but I do want to become more involved as, um, life comes back stable post-COVID," explained one participant. Describing a landscaping idea that would involve all the tenants in her building, this same participant also explained that outreach to neighbors would be necessary, "I know some of my neighbors aren't really, uh, nature friendly, so I feel like I have to, like, I would have to introduce them to it." Stating that "OASP is a legacy," another participant offered an expansive vision of the future for herself, environmental action, and the broader community. With a personal goal of working at the natural history museum, she described also "incorporating that with the whole, like, community garden, and we could do things where we can have, you know, bird walks with just a local community or teaching people about spiders, mushrooms.... People need to know all of this." Thus, despite the far-reaching consequences of the pandemic, the *In the future* category of action documents that some study

participants were still actively envisioning themselves as agents of environmental and community change in the future.

Both survey and interview data demonstrate that participants do act as environmental problem-solvers. Participants reported using their program experience in a variety of ways, and they engaged in environmental problem-solving in a range of directions and at different scales. To some degree, participants completed stereotypical actions associated with environmental stewardship and advocacy, such as donating money, volunteering their time, and signing petitions. In areas of their lives where participants had immediate control, they made decisions that aimed to be environmentally responsible. Participants sought to influence the behavior of family members, friends, and community members, and some became environmental leaders within their social circles, participating in the decision-making process of family environmental practices, and serving as a resource of environmental advice. Some participants connected their choice of career track to the environment, either directly through K-12 science instruction or an environmental career, or indirectly by weaving environmental themes into journalism or public health fields. Finally, some participants have an expansive, long-term vision for what they would like to accomplish in the future, emphasizing the connection between community and the environment.

Summary

In this chapter, I presented the findings of my study examining how a Los Angeles-based informal education program that combines transdisciplinary learning with outdoor, nature-based components influenced students' connection to nature and students' sense of empowerment to address environmental problems. I identified 11 program key elements that participants believed most influential and described the activities at work within and among those elements.

Participants gained a stronger connection to nature and a sense of empowerment through program participation. They participate in a range of nature practices. And, following program participation, they act as environmental problem-solvers, particularly in areas of their life where they have immediate control and social influence. In Chapter Five I will interpret these findings in the context of the literature I presented in Chapter Two. I will also address the limitations of the study, discuss the findings' implications, and present recommendations for future research.

Chapter Five: Discussion

In Chapter One, I described the importance of providing educational opportunities that help students from all backgrounds build identities as creative problem-solvers as an essential and sustainable way to address the global crises we face. In particular, I posited that informal education programs that combine transdisciplinary learning with outdoor, nature-based components may be uniquely positioned to foster problem-solving by students because they combine an array of experiential and reflective practices in contexts distinct from school and home. My study aimed to examine how a Los Angeles-based informal education program that combines transdisciplinary learning with outdoor, nature-based components influenced, if at all, students' connection to nature and students' sense of empowerment to address environmental problems. The following research questions guided my study:

RQ1: What are the key program elements that influence students' relationship to nature and sense of empowerment to address environmental problems?

RQ2: How do key program elements influence students' relationship to nature and sense of empowerment to address environmental problems?

RQ3: Following program participation, in what ways do students (a) view themselves in relation to nature and (b) act as environmental problem-solvers in their own lives?

To address these questions, I conducted an exploratory sequential mixed methods case study, with data collected through an online survey as well as semi-structured interviews of program alumni. The study's findings suggest that numerous key elements are at work within the focal program that influence participants' connection to nature, the development of their problem-solver skills, and their sense of empowerment. Findings also indicate that study participants are engaged in a range of nature practices and do act as environmental problem-solvers in their own

lives. My study finds many parallels in the literature, but also offers an asset-based perspective on urban students' relationship to nature and stewardship.

In this chapter I first review the findings in the context of the literature presented in Chapter Two. I then provide implications for practice, discuss the study's limitations, and suggest directions for future research. I conclude with a personal reflection and a call to action.

Review of the Findings

Key Elements of the Program

Effective transdisciplinary approaches aim to keep students at the center of the learning practice by engaging them in complex cognitive processes beyond just skill acquisition (Bequette & Bequette, 2012; Connor et al., 2015). Study participants described numerous program elements, and I identified 11 as Key Elements that were of primary importance to study participants: *Learning about nature, Spending time outside, Doing hands-on work, Being social with peers, Working in the community, Visiting places that were new to you, Teaching others, Working as a team, Safe Space/Emotional Support/Caring Staff, Communication/Public speaking,* and *Networking/Access to opportunities*. Within and among these program key elements exists substantial space for complex cognitive processes and a range of content from different disciplines.

My findings are similar to those of West (2015), whose study participants also listed environmental knowledge, being outdoors, friendship, community cohesion, and teaching others as program participation outcomes. Several key elements demonstrated a striking alignment with the tenets and outcomes of Positive Youth Development (PYD), despite the fact that the focal program did not consciously adopt a PYD approach. Programs using a PYD approach prioritize community collaboration and establish ways that youth can connect to people and institutions

within their community (Lerner et al, 2005), and the key elements of *Working in the community, Teaching others,* and *Networking/Access to opportunities* align with this approach. *Being social with peers*, *Working as a team, and Communication/Public Speaking* align with the social connection and social competence aspects of Lerner's 5Cs, Benson's 40 developmental assets, and Catalano's 15 PYD constructs (Shek et al., 2019).

Viewing PYD specifically through an environmental education lens, the key elements identified in my study also find some alignment with the work of Schusler (2007, IN Monroe & Krasny, 2016), who identified nine environmental educator practices based on interviews with 33 practitioners. The *Visiting places that were new to you* and *Networking/Access to opportunities* elements of my study correspond with Schusler's *expanding horizons through novel experiences*; while the *Doing hands-on work*, *Working in the community* and *Teaching others* elements corresponds with Schusler's *providing opportunities for meaningful contribution* and *connecting youth with their community*. My study's broadly titled key element of *Safe Space/Emotional Support/Caring Staff* can be seen as thematically overlapping with four distinct practices described by Schusler: *creating safe spaces; building respectful, trusting relationships; bridging differences and creating opportunities for all learners to contribute; supporting youth as they encounter new challenges*.

The key element of *Safe Space/Emotional Support/Caring Staff* is described by other sources as well and is viewed as an essential component to the success of programs that aim to develop youth leadership and empowerment (Bean et al., 2017; Hastings et al., 2011; Salusky et al., 2014). Spaces where the adults in charge make students feel welcome are linked to a higher sense of belonging (Akiva et al.. 2013), and sense of belonging is foundational to motivation, achievement, and effort (Goodenow, 1993; Faircloth and Hamm, 2005). Understanding this

connection between how students feel and their motivation may also help explain their connection to nature, their sense of empowerment, and their actions as environmental problem-solvers.

Participants' Relationship to Nature

Study participants arrived at the program with different relationships to nature, and most did not have a strong connection to nature prior to participating in the program. However, participation in the program resulted in stronger connection to nature and influenced participants beliefs and feelings about nature. Research suggests that supporting students while they engage in communities of practice that are unfamiliar to them changes how students view themselves, providing them with an opportunity to do "identity boundary work" (Carlone et al., 2015, p.1526). One participant, interviewed for this study over a decade after she had completed her time in the focal program, made clear reference to building a nature identity through program participation, stating "...I tend to bring up a nature space as part of my conversations. It's just natural for me, just because, uh, I guess a big, a big part of my, like my, that range of identity involved OASP. I was part of that program when I was creating the identity of myself." Substantiating her statement, other studies indicate that childhood nature experiences have potentially long-term influence on environmental identity (Evans et al., 2018; Wells & Lekies, 2006).

My study suggests that nature identity development – a stronger connection to nature – can occur through program participation. Five program Key Elements were most closely associated with participants' nature connection: *Spending Time Outside*, *Visiting Places that were new to you*, *Doing hands-on work, Learning about nature,* and *Being Social with Peers.* Activities influencing participants' relationship to nature were those that allowed participants to

experience nature first-hand through direct interaction, be a witness to nature, and gain nature knowledge in an outdoor setting with peers. The very act of spending time in nature makes people feel more connected to it (Mayer, 2009), and spending time in nature is linked to more positive environmental behaviors (Alcock et al., 2019). The combination of these key elements and activities may provide participants with positive experiences in nature and nature role models, in the form of staff and peers, both factors that create positive attitudes towards nature and environmental stewardship (Sivek, 2002; Chawla, 2007; Chawla and Derr, 2012). Social factors also influence environmental identity and sense of connectedness to the natural world (Clayton & Opotow, 2003; Fielding & Hornsey, 2016; Riggs Stapleton, 2015). My study indicated that program participants were often motivated by social reasons to join the program, that they met new people, and that they developed and strengthened friendships in the program. Thus, program activities that put first-hand nature experiences in a positive social context may have helped participants to create and reinforce positive attitudes towards nature.

Developing a positive attachment to the natural environment is a prerequisite to developing the kind of problem-solver who can recognize and engage in complex environmental issues. My study indicates that participants engaged in a range of nature practices at home, school, and in local green spaces. Their practices included indirect nature-based engagement that could be done without going outside or interacting with plants or wildlife, as well as outside nature-based engagement practices done outdoors or by interacting directly with plants or animals. “[P]eople are formed in practice, within communities of practice that have histories of participation” (Carlone et al, 2015, p. 1527). Through their efforts to share their nature knowledge, encouraging those within their social circle to participate in outdoor recreation activities, and by example, study participants were actively building a community of nature

practice. The erosion of nature knowledge and connection has been documented (Hejtmánek et al, 2018; Macfarlane, 2015; Louv, 2005; Tewksbury, 2014), as have the array of inequities faced by marginalized communities in accessing nature and open space (Landau et al., 2020; Wood & Esaian, 2020; Pinckney et al., 2018; Scott & Lee, 2018). However, my findings suggest that there is also value in taking an asset-based approach to understanding how urban students engage with nature. Focusing solely on aspects of nature to which urban students lack access may fail to take into account the unique characteristics of urban ecology and the unique ways that urban populations connect with and steward urban nature. When urban areas are viewed as essential spaces for biodiversity conservation and innovative places for climate change mitigation strategies, urban students are then well-positioned to become knowledgeable leaders.

Sense of Empowerment and Environmental Problem-Solving

Participants believed their work in the program had personal, environmental, and community value. They described gaining a range of skills that could position them to be environmental problem-solvers, and they felt a sense of empowerment through program participation. Three Key Elements were most closely associated with both the development of problem-solver skills and sense of empowerment: *Teaching others, Doing hands-on work,* and *Visiting Places that were new to me.* These findings align with outcomes associated with PYD as well as problem-based learning. Components of community connection, collaboration, communication, and addressing real-world issues have been shown to increase student problem-solving skills (Bush et al., 2019; Cantor et al., 2015; Moslemi et al., 2009), and real-world experiences positively impact leadership development (Bush et al., 2019). At both K-12 and higher education settings, outcomes of problem-based learning include student belief that they development of a range of competencies (Dochy et al., 2005; Mossuto, 2009; Cantor et al., 2015;

Moslemi et al., 2009). Within a K-12 setting, problem-based learning has similarly been linked to students' sense of ownership over the learning process (Ferreira & Trudel, 2012) and to self-reported increase in student confidence and knowledge (Kulinski, 2018), which is consistent with my findings. The focal program provided a range of activities that engaged participants in real-world work, from habitat restoration, to teaching younger students, to research projects addressing park management. Monroe and Krasny (2016) describe how environmental education programs, particularly those that employ environmental action, can create "feedback loops" (p.150) for youth that further develop knowledge, skills, and habits. In the context of this study, elements and activities positioned participants to develop problem-solving skills and confidence while they were actively helping to address real-world problems in their community and beyond.

Critiques of evaluation practices in environmental education have focused on the frequent assumption that changes in attitudes necessarily lead to changes in behavior (Marcinkowski & Reid, 2019). Despite the prevalence of environmental awareness campaigns, knowledge alone does not result in pro-environmental behaviors (Bray & Cridge, 2013; Kollmuss & Agyeman, 2002). My study is of value in this area because it described participant attitudes and actions. Following program participation, study participants act as environment problem-solvers in a range of ways, but especially in areas of their life where they have immediate control and influence. They played an active role in stewardship at home and often served as a resource of environmental advice for those within their family and social circle. Other studies have demonstrated that PYD approaches have a positive impact on student attitudes towards civic endeavors (Bush et al., 2019). Outdoor, place-based opportunities may help foster an interest in future involvement in stewardship activities (DuBois et al., 2018). However, my study indicates

that participants not only developed those attitudes and interests, but also followed through with pro-environmental behaviors.

Similar to the discussion above about study participants' connection to nature, my findings suggest that there is value in taking an asset-based approach to understanding how urban students engage in environmental problem-solving in their own lives. Looking beyond a narrow band of stereotypical environmental actions, such as signing petitions, donating money to causes, or volunteering for stewardship events, brings to light a rich array of circumstances where students act as environmental problem-solvers.

Study Implications

The findings of this study contribute to the understanding of informal, nature-based education programs, particularly those that incorporate transdisciplinary learning. This study also highlights that urban students, many of whom are from marginalized communities, value nature, are connected to it where they live, and actively seek ways to be environmental problem-solvers in spaces where they have agency and influence. They engage members of their family and social circles in nature practices and stewardship, and they serve as important resources of nature knowledge to these same social groups. The following recommendations are made with the practitioner in mind.

Recommendations

Program elements – the whole is greater than the sum of its parts. Key program elements identified in the study had considerable overlap in their influence on participants' nature connection, problem-solver ingredient development, and sense of empowerment (Figure 7). The elements are broad, can function concurrently and synergistically, and provide ample space for a diversity of content and activities. It was particularly interesting that, though the focal

program was not explicitly established with strict adherence to Positive Youth Development or problem-based approaches, many of the key elements identified align with those established approaches. For environmental educators seeking a framework or structure on which to develop a program, combining PYD tenets with key elements like Spending time outdoors and Learning about nature may serve to foster both skill development and nature connection.

The focal program, described by one study participant as, "community, um, nature, science, and art kind of all jumbled together," does take an explicitly transdisciplinary approach. From a practitioner's standpoint, there are two elements that did not emerge as being of primary importance to study participants, but that do merit a brief discussion as to what they may contribute to the 11 broader key elements. In Chapter Two, I spent considerable time explaining how the arts and reflective practices greatly benefit learning and contribute to problem-solving. In the focal program, arts and reflective practices are foundational but not conducted in ways that loudly foreground or rationalize their importance. They are just part of process - the "jumble" - for participants, and they may not be as memorably distinct for them as conducting a germination experiment or visiting an endangered species' habitat. However, the use of these practices may be akin to a classroom that a teacher has made into a visually and textually rich environment, where the space is influential in ways that participants may not be consciously aware of or able articulate. One of the few participants who did reference arts activities, said he believed that they "allowed people to find ways in their own backgrounds of how they can be connected with nature."

The second non-key element that merits discussion is the paid aspect of the program. Though it was eclipsed in importance by many other program elements, getting paid was referenced by multiple interview participants as a positive attribute of the program. Two

participants, facing pressure from family to seek employment, explained that getting paid helped remove a barrier to participation in the program. Thus, it may serve as an incentive or a deciding factor to initially participate in the program, and for some, to remain in the program. From a program management standpoint, I posit that though getting paid may not be a key element influencing students' relationship to nature and sense of empowerment to address environmental problems, it is an important tool in program sustainability through recruitment and retention.

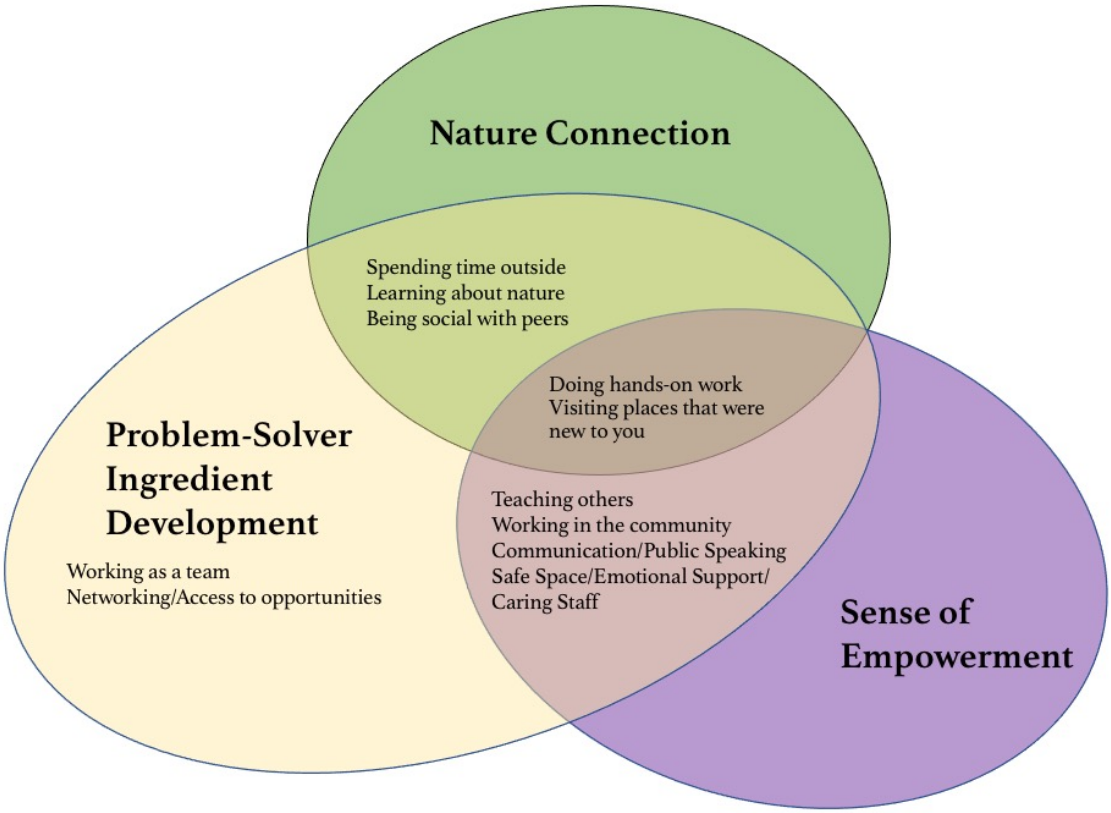

Figure 7. Diagram showing how 11 program key elements overlap in nature connection, problem-solver development, and sense of empowerment.

Put nature in a social context. My study suggests that the social element of the program is a through-line for participants, and other programs may benefit from intentional and thoughtful integration of social opportunities into other aspects of the program. Many participants had

socially motivated reasons for applying to the program. Once in the program they greatly valued shared experiences in nature: they could bond with school friends and see peers in a context outside of school, specifically in a supportive context where everyone was engaged in identity boundary work in their relationship to nature and their development as problem-solvers. “You still get to have fun with the other students,” explained one participant, “...but you're just, you're very aware that what you're doing is important.” Thus, programs that provide participants with the opportunity to have a positive outdoor experience with peers while conducting work that they believe matters may be better able to create the “feedback loops” described by Monroe and Krasny (2016) that further develop participant knowledge, skills, and habits.

Many of the nature activities and environmental problem-solving activities conducted in the program were socially centered and situated visibly in the community at public greenspaces and schoolyard habitats. Students engaged the community directly at times, through teaching, leading volunteer activities, or informal conversations with park users. The evidence of students’ work - green spaces restored - was visible to the community and accessible to students and their families during their time outside the program. Thus, practitioners may want to consider situating student work in a way that is visible in the community.

Take an asset-based approach to understanding urban students’ nature practices and environmental problem-solving. Considerable research exists documenting societal disconnect to nature and systemic inequities at work preventing marginalized communities from accessing nature. Acknowledging, understanding, and seeking to redress these harms is a vital component of solving the myriad environmental crises we face. However, operating from the assumption that marginalized communities only experience nature deficit blinds practitioners and scholars from seeing the adaptable, vibrant, and culturally diverse ways communities may

already be connecting to nature where they live. My study demonstrated that urban students, many of whom are from marginalized communities, not only value nature and engage in a range of nature practices, but also actively seek ways to be environmental problem-solvers in spaces where they have agency and influence. “I feel, like, some of the responsibility of creating that shared space between urban and nature, like it has to involve the people present in that area because we're the one who's upkeeping and making the decisions for everything.” This same participant grows houseplants, takes photos of insects so she can identify them later, advises friends about native plants, and takes younger family members hiking at the local urban park where she participated as a student in the focal program.

Practitioners and scholars should look beyond traditional outdoor recreation practices and stereotypical environmental actions to better understand the complex ways that program participants apply the knowledge and skills they gain to home, work, and school contexts. My study indicates that participants engage members of their family and social circles in nature practices and stewardship, serving as important resources of nature knowledge and technical expertise. They played an active role in stewardship at home and sometimes shape family decision-making. These accomplishments will likely not be accounted for in the usual metrics of volunteerism, money donated, or national parks visited.

Limitations

The findings of this study have to be seen in light of several limitations. First, this study focused on a single program, such that results are not necessarily generalizable to other informal environmental education programs. My hope, despite the lack of generalizability, is that insights gained through this study spur future research and continued discussion about how nature and transdisciplinary approaches can shape students’ thinking. Second, the study relied on data

collected from participants who opted into participation. An effort was made to contact as many program alumni as possible for the survey as well as to select interview participants representing the spectrum of alumni diversity. However, those with negative or neutral feelings about the program were unlikely to respond to any solicitations to be a participant, as it would require them to take personal time to do so. Those who did choose to participate likely had positive feelings and associations about the program and were therefore willing to take personal time to participate. Thus, the views represented in the study are not necessarily representative of all program alumni. Third, given the timeframe of the study, it was not possible for multiple researchers to code and cross-check the interview data. Because a single researcher coded all the interviews, reliability of the coding scheme may be in question. Also, the focus on only interview and survey data left other rich sources of data unexplored. For example, using student field notebooks and collaborative student work products as sources of data to address similar research questions about the effects of transdisciplinarity and nature on student thinking may offer different insights from those gained through interviews and surveys. Fifth, reactivity should also be considered, as I personally know and have worked with all study participants in the capacity of a supervisor and/or educator. Finally, it is extremely important to note that this study was conducted during the covid-19 pandemic. The long-term collective stress of the pandemic combined with the fatigue of relying on online platforms to communicate may have affected not only the number of alumni willing to participate in the study but also the perspectives of those who did choose to participate.

Suggestions for Future Research

Given the current study's limitations, one of the primary areas for future research would be to conduct similarly designed case studies of other informal, nature-based education programs

that incorporate transdisciplinary learning. Do participants in other programs identify the same key elements, and do they experience similar outcomes related to connection to nature, sense of empowerment, and action as problem-solvers? In addition to this broad suggestion for a research direction, and keeping the lens on informal, nature-based education programs that incorporate transdisciplinary learning, the richness of qualitative data from this study offered several other entry points for future research.

Multiple study participants made a distinction between the focal program and school, with one participant repeatedly stating that the program was "bigger than school," and another describing it as "like a lab in the real world." At the same time, study participants also reported applying knowledge and skills they gained in the focal program to academic settings. Future research focused on understanding the interplay between school and programs like the one in this study in students' lives could benefit both formal and informal education settings. This is especially true for programs that attract students from a range of academic achievement levels.

Study participants' discussions of how program participation influenced their social life provides another direction for future research. One participant, who was in the focal program over a decade ago, said that she could, "still remember certain conversations that I've had that I had with them [peers] at the greenhouse." Other participants described the importance of working with a diverse group of peers in the program, making lasting friendships, and having the opportunity to interact with peers outside of a school context. How do programs like the focal program influence the establishment and strengthening of social bonds for students? And, what are the longer-term ramifications for nature and stewardship practices in students' lives once they have established a social support network for these activities?

Another important social aspect that merits further study is a program's influence on the family dynamics surrounding nature connection and stewardship. Study participants described their efforts, and successes, in influencing environmental decision-making at home. How does student knowledge and experience gained in the program add to their families' capital? For example, students may influence family decision-making that results in lowering water and energy bills, positive health outcomes through nature practices, and providing younger family members with access to information about environmental career tracks. Conversely, in what ways are families' existing nature and stewardship practices influencing a program over time? One participant, contrasting his urban upbringing with the rural upbringing of his grandparents, said his participation in the focal program helped him to understand his grandparents' at-home nature practices: "basically, I just caught up to what they were doing." How can a culturally responsive program be permeable to the cultural practices and knowledge that students bring with them to the program?

Numerous interview participants linked nature connection to their mental health and well-being. Further research might explore the role that programs like the study program play in helping students develop habits and practices that support their physical and mental health. What program activities influence students in making that link between nature access and well-being, and how do students implement those practices in their own lives outside of a program? This topic could lend itself especially well to a participatory action research approach, with students themselves designing and implementing a study with adult support.

Finally, how do students conceptualize the creative, arts-based endeavors they engage in when participating in nature-based, transdisciplinary programs? In this study, arts-based activities did not emerge as a key element for participants, despite the fact these activities are a

routine part of the program. Do students privilege STEM knowledge and skills over arts-based skills; if so, what drives that privileging process? And, how can program educators instill in students an explicit awareness of the important role that arts practices play in a transdisciplinary approach to problem-solving?

Reflection, Conclusion, and Call to Action

For just the span of my time as a student in UCLA's Education Leadership Program, I can create a long and still-incomplete list of environmental catastrophes. Even if reduced in scope to places to which I have a direct connection, the list would still be long. Paradise, California, the town just up the hill from my own hometown, was wiped out by fire in 2018. My hometown then absorbed tens of thousands of what I would consider to be "climate refugees" from Paradise, putting a substantial number of these now-unhoused neighbors in the same refugee category as those arriving at the U.S. border fleeing floods, droughts, and the accompanying economic devastation that can follow. Here in Los Angeles and the greater Southwest, 40 million Americans are uncertain about how they will continue to get water from a depleted Colorado River. And, occurring within just a few months of one another, a sewage spill and an oil spill along the Southern California coast forced beach closures at sites where I both conduct bird surveys as a project biologist and regularly swim. Concurrent with this personalized list of environmental disasters, we are still in the midst of a global pandemic, a nation-wide reckoning for racial justice sparked by the murder of George Floyd, and the fall-out from a breach of the U.S. Capitol. All this, in just my time as an ELP student.

Our present and future offers no shortage of "wicked problems," aptly named for their complexity and near-intractability (Cantor et al., 2015). First acknowledging them and then attempting to address them requires an intimidating list of ingredients: irrepressible imagination;

an array of ancient systems of knowledge as well as still-evolving expertise; a profound faith in our own species; and the individual humility to be one tiny collaborator among many in a society that is perpetually glorifying the lone genius. So, it is difficult to be an environmental educator most of the time. But, the opportunity to conduct my study was the gift of a lifetime.

"I don't think people would join this program if they weren't sort of curious about the world," stated one participant, a student who embraced transdisciplinary thinking throughout his three years in the program. Curiosity is a good starting point to problem-solving, certainly preferable to guilt and despair. What participants themselves had to say over the course of the study suggests that an after-school program that meets a couple times a week at local urban greenspaces can influence how students view nature, community, and their responsibility to both. The study's focal program takes place on public land and does not rely on expensive equipment. It does require intellectual and physical labor from staff and students, the development of an environmental literacy that includes a "literacy of the fingers" (Tilston, 2015). The muscle memory that develops from transplanting seedlings becomes tied to a positive social experience and information not taught at school. The program pushes students to think about problems transdisciplinarily, where a haiku poem, a carefully observed botanical drawing, and a data form are all equally important protocols to understanding the same issue. And finally, the social, supportive aspects of collaborative work leave students understanding that they "need to establish a group of people you can strive with," as one interview participant stated.

I would like to end this chapter with a call to action to leaders in schools, libraries, parks, faith-based communities, and non-profit organizations. Wicked problems require a diversity of worldviews and contexts for understanding. Let's strive together to create these entry-points for students to connect to nature and to actively engage in environmental problem-solving in a way

that is visible to the community. The community needs to see that young people care, and specifically, that they care about nature and see its value to the community. Perhaps wicked problems may best - most optimistically - be viewed as invitations for seemingly disparate, intergenerational collaborators to visualize new ways of living together as part of the biosphere. We need to start now, imperfectly, learning as we go.

Appendix A: Participant Recruitment Materials

Recruitment Communication Templates

Communications to full-time staff members with LANPO

[Initial email contact]
Subject: OASP UCLA Study
Hi [participant name here],

As you know, I'm currently working on my doctorate in education through UCLA. I've decided to focus my dissertation study on better understanding OASP's influence on student thinking about nature and stewardship. This study engages program alumni. My hope is that the information gathered will help us make OASP stronger and may also be useful for other organizations working with youth in an environmental context.

As a current staff member and former program participant, you are uniquely situated to offer valuable insight based on your own experiences. Your participation in the study would be entirely voluntary – it is definitely not a work requirement. Would you be willing to participate in an interview through Zoom or Google Meet, or by phone? Participants who complete an interview will receive a $10 gift card.

I'm also trying to connect with as many alumni as possible for this study. Please consider reaching out to any alumni who might be in your personal network to share with them this link for participation: https://forms.gle/xHzJCcSXqojNVX3WA. I've also attached a digital flyer (pdf with live-link, and jpg that's image-only) that LANPO will be using on social media.

Thank you for your time and consideration!

Stacey Vigallon

Communications to seasonal staff members not currently employed with LANPO

[Initial email contact]
Subject: OASP UCLA Study
Hi [participant name here],

I hope this email finds you well! I'm currently working on my doctorate in education through UCLA. I've decided to focus my dissertation study on better understanding the OASP's influence on student thinking about nature and stewardship. This study engages program alumni. My hope is that the information gathered will help us make OASP stronger and may also be useful for other organizations working with youth in an environmental context.

As a former OASP student and as an alumnus/a who has come back to help lead program activities, you are uniquely situated to offer valuable insight based on your own experiences. Would you be willing to participate in an interview through Zoom or Google Meet, or by phone? Participants who complete an interview will receive a $10 gift card.

I'm also trying to connect with as many alumni as possible for this study. Please consider reaching out to any alumni who might be in your personal network to share with them this link for participation: https://forms.gle/xHzJCcSXqojNVX3WA. I've also attached a digital flyer (pdf with live-link, and jpg that's image-only) that LANPO will be using on social media.

Thank you for your time and consideration!

Stacey Vigallon

Communications to adult alumni

Note: The research information sheet was built in to the Qualtrics survey, preceding the questions. For alumni selected for interviews, the research information sheet was also provided to them prior to the interview.

[Initial email contact]
Subject: OASP UCLA Study
Hi [participant name here],

I hope this email finds you well!

LANPO is collaborating with UCLA on a study to better understand students' experience in OASP. As a former OASP student yourself, you are uniquely situated to offer valuable insight for this research.

We're hoping you would be willing to share your insight by participating in a survey. This survey is anonymous and will take only 10-15 minutes to complete. Questions are focused on your thoughts and opinions about your time in OASP, nature, and community.

Take the survey here:
http://uclaed.co1.qualtrics.com/jfe/form/SV_08mHXjAqGNlOuea

Your voice and experience matter. Results from this study will help inform decision-making about OASP and other LANPO education programs. Results from this study may also be useful for other organizations working with youth in an environmental context.

Please feel free to contact me with any questions you might have.

Thank you for your consideration!

Stacey Vigallon

[Initial contact regarding survey – text message]
Hi [participant name here]! This is Stacey from OASP. LANPO is collaborating with UCLA on a study to better understand students' experience in OASP. We're hoping alumni will share their valuable insight by participating in this survey:

http://uclaed.co1.qualtrics.com/jfe/form/SV_08mHXjAqGNlOuea

Thanks for your consideration!

[Initial contact regarding survey - Facebook direct message]
Hi [participant name here]! LANPO is collaborating with UCLA on a study to better understand students' experience in OASP. We're hoping alumni will share their valuable insight by participating in this survey:

http://uclaed.co1.qualtrics.com/jfe/form/SV_08mHXjAqGNlOuea

Thanks for your consideration!

Communications to alumni who are minors

[Initial email contact]
Subject: OASP UCLA Study
Hi [participant name here],

As you may know, I'm currently working on my doctorate in education through UCLA. I've decided to focus my dissertation study on better understanding OASP's influence on student thinking about nature and stewardship. This study engages program alumni, including current students who have completed at least one year in the OASP. My hope is that the information gathered will help us make OASP stronger and may also be useful for other organizations working with youth in an environmental context.

As a current OASP student, you are uniquely situated to offer valuable insight based on your own experiences. Your voice matters, and I'd like to make sure that your perspective is represented in the study I'm doing through UCLA.

Your participation in the study would be entirely voluntary – it is definitely not an OASP requirement. Participating would include completing an online survey and possibly being interviewed.

If you are interested in participating, please complete the attached permission form. You will need a parent/guardian signature, and then send me a scan/photo of the form.

Thank you for your time and consideration!
Stacey Vigallon

Study Information Sheet

University of California, Los Angeles

Research Information Sheet

TITLE OF STUDY**:** Nature and Transdisciplinarity: Pathways to Problem-Solving?

PRINCIPAL INVESTIGATOR: Stacey Vigallon

SPONSOR: Dr. William Sandoval

The following information is provided to inform you about this research study and your participation in it. Please read this information carefully and feel free to ask any questions you may have. Your participation in this study is voluntary. You are free to not answer any questions or to end your participation at any time. Withdrawal or refusal to participate will not be held against you in any way.

Why is this study being done?
This study is being done to better understand how OASP fosters students' connection to nature and their sense of empowerment to address environmental issues. We are surveying and interviewing program alumni.

What will happen if I take part in this research study?
If you volunteer to participate in this study, the researcher will ask you to do the following:

- Volunteer 10-15 minutes of your time to complete an online survey and/or
- Volunteer 30-60 minutes of your time for an interview by phone, Zoom, or Google Meet, which will be audio-recorded
- Possibly volunteer 15-30 minutes to complete a member check (a review of preliminary findings to make sure your perspective is accurately depicted)

How long will I be in the research study?
Your role in the research study will be complete once you submit the online survey, complete the interview, or complete a follow-up member check.

Are there any potential risks or discomforts that I can expect from this study?
There are no risks associated with your participation in this study.

Are there any potential benefits if I participate?
Program alumni are uniquely situated to offer valuable insight based on their own experiences. The information gathered through this study will help inform decision-making about OASP and other LANPO education programs. Results from this study may also be useful for other organizations working with youth in an environmental context.

Will I be paid for my participation?
Participants who complete an interview will receive a $10 gift card.

Will information about me and my participation be kept confidential?
The researchers will do their best to make sure that your private information is kept confidential. Information about you will be handled as confidentially as possible, but participating in research may involve a loss of privacy and the potential for a breach in confidentiality. Study data will be physically and electronically secured. As with any use of electronic means to store data, there is a risk of breach of data security. Your data, including de-identified data may be kept for use in future research.

What are my rights if I take part in this study?

- You can choose whether or not you want to be in this study, and you may withdraw your consent and discontinue participation at any time.
- Whatever decision you make, there will be no penalty to you, and no loss of benefits to which you were otherwise entitled.
- You may refuse to answer any questions that you do not want to answer and still remain in the study.

Who can I contact if I have questions about this study?

- If you have any questions, comments or concerns about the research, you can talk to the researcher: Stacey Vigallon, (323) 481-4037, svigallon@gmail.com
- If you have questions about your rights as a research subject, or you have concerns or suggestions and you want to talk to someone other than the researchers, you may contact the UCLA OHRPP by phone: (310) 206-2040; by email: participants@research.ucla.edu or by mail: Box 951406, Los Angeles, CA 90095-1406.

You will be given a copy of this information to keep for your records.

Parent Permission Form
University of California, Los Angeles

PARENT PERMISSIONFOR MINOR TO PARTICIPATE IN RESEARCH

TITLE OF STUDY**:** Nature and Transdisciplinarity: Pathways to Problem-Solving?

PRINCIPAL INVESTIGATOR: Stacey Vigallon

SPONSOR: Dr. William Sandoval

The following information is provided to inform you about this research study and your child's participation in it. Please read this information carefully and feel free to ask any questions you may have. Your child's participation in this study is voluntary. He/She/They are free to not answer any questions or to end participation at any time. Withdrawal or refusal to participate will not be held against your child in any way.

Why is this study being done?
This study is being done to better understand how OASP fosters students' connection to nature and their sense of empowerment to address environmental issues. We are surveying and interviewing program alumni, including current OASP students who have completed at least one year of the program.

What will happen if my child takes part in this research study?
If your child volunteers to participate in this study, the researcher will ask them to do the following:

- Volunteer 10-15 minutes of their time to complete an online survey and/or
- Volunteer 30-60 minutes of their time for an interview by phone, Zoom, or Google Meet, which will be audio-recorded
- Possibly volunteer 15-30 minutes to complete a member check (a review of preliminary findings to make sure participant perspectives are accurately depicted)

How long will my child be in the research study?
Your child's role in the research study will be complete once they submit the online survey, complete the interview, or complete a follow-up member check.

Are there any potential risks or discomforts that my child can expect from this study?
There are no risks associated with your child's participation in this study.

Are there any potential benefits if my child participates?
Program alumni are uniquely situated to offer valuable insight based on their own experiences. The information gathered through this study will help inform decision-making about OASP and other LANPO education programs. Results from this study may also be useful for other organizations working with youth in an environmental context.

Will my child be paid for participating?

Participants who complete an interview will receive a $10 gift card.

Will information about my child and their participation be kept confidential?
The researchers will do their best to make sure that your child's private information is kept confidential. Information about your child will be handled as confidentially as possible, but participating in research may involve a loss of privacy and the potential for a breach in confidentiality. Study data will be physically and electronically secured. As with any use of electronic means to store data, there is a risk of breach of data security. Your child's data, including de-identified data, may be kept for use in future research.

What are my child's rights if they take part in this study?

- Your child can choose whether or not they want to be in this study, and your child may withdraw consent and discontinue participation at any time.
- Whatever decision your child makes, there will be no penalty to them, and no loss of benefits to which they were otherwise entitled.
- Your child may refuse to answer any questions that they do not want to answer and still remain in the study.

Who can I contact if I have questions about this study?

- If you have any questions, comments or concerns about the research, you can talk to the researcher: Stacey Vigallon, (323) 481-4037, svigallon@gmail.com
- If you have questions about your rights as a research subject, or you have concerns or suggestions and you want to talk to someone other than the researchers, you may contact the UCLA OHRPP by phone: (310) 206-2040; by email: participants@research.ucla.edu or by mail: Box 951406, Los Angeles, CA 90095-1406.

Statement of Parent/Guardian of a Child Participant

I have read this informed consent document. All of my questions have been answered, and I consent as parent/guardian to allow my child to voluntarily participate in this study.

_____
Child's Full Name

_____
Signature of Parent/Guardian

_____
Printed Name of Parent/Guardian

_____
Date

You will sign the form and email an image of the signature page to me at svigallon@gmail.com. Please keep a copy for your records.

Appendix B: Staff Alumni Interview Protocol

Opening Questions

1) What high school did you attend and when did you graduate?
2) Tell us about your educational and professional background.
3) What is your history with this program?
4) How did you become a staff member in this program? [*this question may not be needed if they address this in Q3*]

Introductory Question

5) How do you describe this program to others?
6) When you think about your time in the program, what are some things that come to mind?

Transition Question

7) Tell me about your relationship with nature now and how it has or hasn't changed since before you started the program.

Key Questions

Thinking back to your time as a student in the program:

8) How did the program influence your way of thinking, compared to people you know who weren't in this program? [*narrow to environmental theme if they need more focus, but otherwise keep vague at start to see if we catch other lines of thought*]
9) Tell us about any changes you noticed in your every-day behavior when you were a student based on something you learned in the program.
10) Did your ideas about caring for the environment or community change once you were in the program? [*skip this question if they adequately discuss this theme in Q8*]
12) What would you describe as the key elements of the program?
13) Which program activities had the biggest impact on you?
14) How do you feel you benefited from being in the program?
15) How, if at all, did you being in the program influence your family's relationship to nature? [*provide examples if they have trouble thinking of things*]
16) How, if at all, did you being in the program influence your friend group's relationship to nature? [*provide examples if they have trouble thinking of things*]
17) How did the program make you feel about being a community member?
18) What do you view as your role in the community now or in the future?
19) Has something you learned in the program (knowledge or skill) ever been helpful to you in solving a problem or accomplishing a task in your life?
20) Describe how your experience in the program influenced your life after high school?
21) How, if at all, do you feel the program prepared you to address environmental problems facing our communities?
22) What are some things you do now that reflect your values related to nature and the environment?

Now thinking about your role as a staff member in the program:

23) How would you describe the program staff's approach to teaching students?
24) How do you think the program influences students' way of thinking?
25) How does this program help students connect to nature?

26) How does this program get students to address environmental issues?
27) How does the program position students to engage with their community?
28) How does the program position students to engage in leadership activities?
29) How has the program evolved over time?
30) How do students benefit from this program?
31) What lasting impacts have you observed in students that you might attribute to program participation?
32) Could you describe some examples of how you have seen students grow in this program?
33) What are the strengths of this program?

Ending Questions

34) In just one or two sentences, how would you summarize your feelings about the program?
35) Is there anything we missed?

Appendix C: Non-staff Alumni Interview Protocol

Opening Questions

1) What high school did you attend and when did you graduate?
2) Tell me about your educational and professional background.

Introductory Question

3) Think back to when you first got that blank program application form. What motivated you to actually fill it out and turn it in?

Transition Questions

4) When you think about your time in the program, what are some things that come to mind?
5) [probe] Tell me about an experience in the program that was positive for you.
6) Tell me about your relationship with nature now and how it has or hasn't changed since before you started the program.

Key Questions

7) What would you say are the key elements or ingredients of OASP?
8) How would you describe the mindset at OASP?
9) Which program activities had the biggest impact on you?
10) [probe] What was it about those activities that made them significant for you?
11) How did the program influence your way of thinking, compared to people you know who weren't in this program? [*narrow to environmental theme if they need more focus, but otherwise keep vague at start to see if we catch other lines of thought*]
12) Tell me about any changes you noticed in your daily behavior when you were a student based on something you learned in the program.
13) Did your ideas about caring for the environment or community change once you were in the program? [*skip this question if they adequately discuss this theme in Q10*]
14) How, if at all, did you being in the program influence your family's relationship to nature? [*provide examples if they have trouble thinking of things*]
15) How, if at all, did you being in the program influence your friend group's relationship to nature? [*provide examples if they have trouble thinking of things*]
16) How did the program make you feel about being a community member?
17) What do you view as your role in the community now or in the future?
18) Do you feel like the work you did in the program was important or had any lasting value?
19) How do you feel you benefited from being in the program?
20) Has something you learned in the program (knowledge or skill) ever been helpful to you in solving a problem or accomplishing a task in your life?
21) How, if at all, do you feel the program prepared you to address environmental problems facing our communities?
22) What are some things you do now that reflect your morals and values related to nature and the community?

Ending Questions

23) Is there anything I missed?

Appendix D: Survey Protocol

Q1. What high school did you attend when you were in OASP?

- Dorsey High School
- Culver City High School
- Hamilton High School
- Other

Q2. What is your high school graduation year?

- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022

The questions that follow will ask you to think about your experience as a program participant.

Q3. Please select how <u>useful</u> the following activities were to you when you were in OASP. [options: not useful, somewhat useful, very useful, not applicable]

- Spending time outside
- Learning about nature
- Doing science
- Doing hands-on work
- Being social with peers
- Working as a team
- Doing activities that involved art or craft
- Doing real-world projects
- Discussions with staff and peers
- Teaching others
- Working in the community
- Doing activities that involved self-reflection or mindfulness
- Visiting places that were new to you
- Activities that were centered on food
- Getting support with the college application process
- Receiving a stipend or project funding
- Other (please describe)

Q4. Please select how meaningful the following activities were to you when you were in OASP.
[options: not meaningful, somewhat meaningful, meaningful, extremely meaningful, not applicable]

Spending time outside
Learning about nature
Doing science
Doing hands-on work
Being social with peers
Working as a team
Doing activities that involved art or craft
Doing real-world projects
Discussions with staff and peers
Teaching others
Working in the community
Doing activities that involved self-reflection or mindfulness
Visiting places that were new to you
Activities that were centered on food
Getting support with the college application process
Receiving a stipend or project funding
Other (please describe)

Please reflect on how OASP **may have influenced you in the following ways:**

Q5. When I attended the program…
[options: strongly agree, agree, disagree, strongly disagree, not applicable]

I learned things about myself.
I gained new skills and/or knowledge.
I felt like the work I did mattered.
I felt like I was part of my community.
I saw ways that I could teach other people things I learned.
I met people I might not have had the opportunity to work with before.
I formed friendships with people in the program.
I had the opportunity to be a leader.
I learned that there are different ways to be a leader.
I began to better understand my own morals and values as they related to family and community.

Q6. When I attended the program…
[options: strongly agree, agree, disagree, strongly disagree, not applicable]

I formed a stronger connection to nature and the environment overall.
I grew more comfortable being outdoors.
I overcame some fear I had about nature.
I began to see some parks or green spaces as “mine”.
I began to feel like I belonged in nature.
I grew to better understand nature in/near my neighborhood.

I started to feel more connected to parks or green spaces I visited regularly when I was a child.
I grew to better understand my own morals and values as they related to nature.
I changed some of my own behaviors to be more environmentally friendly.
I tried to change the behaviors of friends and family members to be more environmentally friendly.

Q7. When you were in OASP, did you…
[options: strongly agree, agree, disagree, strongly disagree, not applicable]
Feel like you could share your own personal interests?
Have opportunities to think deeply about complex issues?
Have opportunities to reflect on your own life experiences?
Have opportunities to express your opinions?
Feel like you could be yourself?
Feel like OASP was a place to escape from challenges at home or school?
Feel like staff members cared about you?
Feel like staff members wanted you to succeed?

Q8. By attending the program, did your knowledge or understanding of the following change?
[options: greatly increased, increased, did not change, not applicable]
Environmental issues
Community issues
Plants and wildlife
Understanding how different issues might actually be connected
The process of doing science

Q9. By attending the program, did your skill levels in the following areas change?
[options: greatly increased, increased, did not change, not applicable]
Observational skills
Art, design, or craft skills
Organizational skills
Ability to identify the steps a task might require
Collecting data
Using data to support an idea
Confidence to solve problems
Time management skills
Self-discipline and self-accountability
Outdoor skills
Leadership skills
Oral communication (public speaking) skills
Written communication skills
Ability to work in a team

Q11. Did participating in OASP connect you with other opportunities outside the program?
Please select all that apply:
Jobs

Internships
Volunteer opportunities
Scholarships
Public presentations
Conferences/conventions
Other programs (camps, workshops, etc.)
Opportunities to publish writing
Opportunities to display artwork
Social activities
Other

Q12. When you were in the program, did you have an opportunity to connect with any of the following people? Please select all that apply.

Professionals working in different careers
Undergraduate or graduate students pursing different majors
Former students who had already been through the program (alumni)
Other

Q13. Briefly describe what you found most valuable about your experience in the program.
[open-ended written response]

The questions in this section will ask you to reflect on how you may have applied your experience in OASP **to other parts of your life.**

Q14. Since participating in OASP, I…
[options: never, rarely, sometimes, frequently]

Pay more attention to issues in the news.
Notice more about my surroundings.
See how issues connect or overlap.
Consider multiple ways to approach a project or a problem.
Identify things I would like to change in my neighborhood or community.
Take time to think before I decide how to approach a project or problem.
Feel more comfortable speaking to new people.
Share my science or nature knowledge with others (friends, family, peers, strangers).

Q15. I am someone who…
[options: never, rarely, sometimes, frequently]

Participates in organized environmental stewardship and/or social justice activities.
Signs online petitions for change (legislation, boycotts, etc.)
Donates money to causes that are important to me.
Takes an active role in stewardship at home when I can (such as recycling, minimizing food waste, etc.).
Thinks about environmental sustainability and ethical production when making purchases.
Finds ways to help family and friends when I can.
Participates in creative work - like dance, art, craft, writing, or music.
Feels like I have a place in my community.
Feels a sense of responsibility to my community.

Likes learning new things.

Q16. I am someone who…
[options: never, rarely, sometimes, frequently]
Spends time outdoors.
Finds nature a source of inspiration.
Believes that access to nature can support health.
Visits local parks or green spaces (including the beach).
Visits parks and green spaces distant from where I live.
Likes picnics, BBQs, and eating meals outside.
Enjoys seeing wildlife.
Likes identifying the types of plants and wildlife I see.
Goes camping or backpacking.
Grows plants when I can.
Has nature apps on my phone.
Likes to watch nature videos, shows, and films.
Likes to learn how other cultures engage with nature.
Encourages friends and family members to do activities outdoors.
Takes short "nature breaks" during the day to refresh.
Likes to work near a window with a view of the outdoors.
Likes to exercise outdoors.

Q17. I believe that I…
[options: strongly agree, agree, disagree, strongly disagree, not applicable]
Have the power to make a difference in my family.
Have the power to make a difference in my community.
Can express myself through speaking and/or writing about an issue that is important to me.
Can collaborate with others to accomplish a goal.
Can lead a team to accomplish a goal.
Can work on my own to accomplish a goal.
Can recognize when I need to seek expertise from someone else in order to accomplish a goal.
Can recognize the strengths I bring to a project.

Q18. I have used my program experience in the following ways (please select all that apply):
To see connections between program content and what I learn in class.
As a source of information or as an example in a school project or paper.
As a source of information or as an example in a personal project.
As a source of information or as an example in a professional project.
As a way to check out a nature area that I can then take my family/friends to later.
Cite relevant program experience as a way to get a job, internship, scholarship, or other opportunity.
To inform my choice of college major or career track.
Inform my decisions when I vote
Other (please describe)

None of the above

Q19. If you have already graduated high school, how do you stay connected to the program? (please select all that apply)
Follow the program on social media
Stay in touch with staff members
Stay in touch with fellow program participants
I do not stay in touch with the program.
Other

Q20. Is there anything else that you feel we should know about your experience?

Demographics

Q21. To which gender identity do you most identify?
Male
Female
Gender Non-Conforming

Q22. To which Race/Ethnicity do you most identify?
Latinx or Hispanic
Black or African American
Asian
American Indian or Alaska Native
Native Hawaiian and Pacific Islander
White
Other

Q23. What is the highest degree or level of school you have completed?
Some high school
High school graduate, diploma or the equivalent (for example: GED)
Some college, no degree yet
Trade/technical/vocational training
Associate degree
Bachelor's degree
Master's degree
Professional degree
Doctoral degree

Q24. In the space below, please briefly describe your career track of interest. You may already be working in this field, or you may be planning to in the future (e.g., public health, engineering, landscaping, education, solar installation, animation/illustration, etc.).

Appendix E: Additional Analyses

Survey data and connections among competence, nature connection, and empowerment

In Chapter Four, the survey data are largely used to provide context for or show alignment with interview data. But, I also wanted to see what quantitative data alone could reveal about the interaction among competences gained through the program, relationship to nature, and sense of empowerment. I created five composite variables for respondents by converting Likert scales to numerical values and aggregating thematically related questions: Action/Empowerment, Community Connection, Nature Connection, Self/Identity, and Environmental Problem-Solving (Table 10). The goal was to examine any relationships that might occur among the composite variables. For example, do respondents who score high in the nature connection composite variable also score high in the environmental problem-solving composite variable?

Of the five composite variables, four of them had average scores >85% of the maximum possible. The Environmental Problem-solving composite variable average score was also high but was 76% of the maximum possible (Table 11). There were statistically significant correlations among all the composite variables with one another, whether using a parametric or non-parametric test (Table 12), with one exception. Community Connection and Nature Connection are not correlated to a statistically significant level when compared using a parametric test.

Simply put, respondents who had high scores in one composite variable had high scores in the other composite variables. While little nuance was revealed through this analysis, these results serve to highlight overall interconnectedness among participant perceptions of nature, community, and their competence in problem-solving.

Table 10. Composite variables for respondents, developed by converting Likert scales to numerical values and aggregating thematically related questions.

Composite Variable	Composite Score Range	Qualtrics Survey Question Number and Text
Action/Empowerment Respondents' actions taken while in the program and sense of empowerment	0-14	Q17_3: I felt like the work I did mattered. Q17_8: I had the opportunity to be a leader. Q19_9: I changed some of my own behaviors to be more environmentally friendly. Q19_10: I tried to change the behaviors of friends and family members to be more environmentally friendly. Q24_7: Confidence to solve problems
Community Connection Respondents' feelings about their community and their place in it	0-9	Q17_4: I felt like I was part of my community. Q17_6: I met people I might not have had the opportunity to work with before. Q17_7: I formed friendships with people in the program.
Nature Connection Respondents' sense of connection to nature	0-23	Q19_1: I formed a stronger connection to nature and the environment overall. Q19_2: I grew more comfortable being outdoors. Q19_4: I began to see some parks or green spaces as "mine" Q19_5: I began to feel like I belonged in nature. Q19_6: I grew to better understand nature in/near my neighborhood. Q19_7: I started to feel more connected to parks or green spaces I visited regularly when I was a child. Q19_8: I grew to better understand my own morals and values as they related to nature. Q24_10: Outdoor skills
Self/Identity Respondents' sense of self and identity and feelings about how/if the program supported them	0-30	Q17_1: I learned things about myself. Q17_10: I began to better understand my own morals and values as they related to family and community. Q17_2: I gained new skills and/or knowledge. Q22_1: Feel like you could share your own personal interests? Q22_3: Have opportunities to reflect on your own life experiences? Q22_4: Have opportunities to express your opinions? Q22_5: Feel like you could be yourself? Q22_6: Feel like OASP was a place to escape from challenges at home or school?

		Q22_7: Feel like staff members cared about you? Q22_8: Feel like staff members wanted you to succeed?
Environmental Problem-Solving Combined Skills and knowledge that are components of or would aid in environmental problem-solving; this is a combined score of the sub-categories described below	0-43	See sub-categories below
Env. Problem-Solving - background knowledge Knowledge gained about environmental issues, plants and wildlife, community issues	0-6	Q23_1: Environmental issues Q23_2: Community issues Q23_3: Plants and wildlife
Env. Problem-Solving – collaboration Skills gained in teamwork and leadership practices	0-10	Q17_5: I saw ways that I could teach other people things I learned. Q17_9: I learned that there are different ways to be a leader. Q24_11: Leadership skills Q24_14: Ability to work in a team
Env. Problem-Solving – communication Skills gained in oral, written, and visual communication	0-8	Q24_12: Oral communication (public speaking) skills Q24_13: Written communication skills Q24_2: Art, design, or craft skills Q24_6: Using data to support an idea
Env. Problem-Solving - framing the problem Skills gain such as collecting data, thinking about the steps required, seeing connections, and just thinking about a thing	0-11	Q22_2: Have opportunities to think deeply about complex issues? Q23_4: Understanding how different issues might actually be connected Q23_5: The process of doing science Q24_4: Ability to identify the steps a task might require Q24_5: Collecting data
Env. Problem-Solving - self skills Skills gained such as observing, being organized, self-disciplined, time management	0-8	Q24_1: Observational skills Q24_3: Organizational skills Q24_8: Time management skills Q24_9: Self-discipline and self-accountability

Table 11. Descriptive statistics for composite variables.

	Action/ Empowerment	Community Connection	Nature Connection	Self/ Identity	Env problem-solving (sub-categories combined)
Sample size	52	52	52	52	52
Mean	11.808	8.135	20.231	26.365	32.885
Std. Deviation	2.105	1.534	2.617	3.436	8.050
Minimum	6.000	0.000	14.000	17.000	12.000
Maximum	14.000	9.000	23.000	30.000	43.000

Table 12. Correlation matrix for composite variables.

Composite Variable Comparison	Pearson		Spearman	
	r	p	rho	p
action/empowerment - community connection	0.554***	< .001	0.580***	< .001
action/empowerment - Nature connection	0.560***	< .001	0.600***	< .001
action/empowerment - Self/Identity	0.747***	< .001	0.700***	< .001
action/empowerment - Env problem-solving combined	0.731***	< .001	0.757***	< .001
community connection - Nature connection	0.256	0.067	0.517***	< .001
community connection - Self/Identity	0.597***	< .001	0.669***	< .001
community connection - Env problem-solving combined	0.292*	0.036	0.471***	< .001
Nature connection - Self/Identity	0.649***	< .001	0.687***	< .001
Nature connection - Env problem-solving combined	0.550***	< .001	0.611***	< .001
Self/Identity - Env problem-solving combined	0.706***	< .001	0.667***	< .001

* p < .05, ** p < .01, *** p < .001

Survey data and connections among nature practices, empowerment, and stewardship actions

As with the preceding section addressing activities of influence, survey data has largely been used provide context for or to substantiate interview data. I also wanted to see what

quantitative data alone could reveal about the interaction between nature relationship and stewardship action. I created four composite variables – Action, Nature Practice, Problem-solving Disposition, and Sense of Empowerment - for respondents by converting Likert scales to numerical values and aggregating thematically to related questions (Table 13). The approach aimed to take into account not only participant actions and nature practices, but also how participants saw themselves, their skills, and their sense of empowerment to use those skills.

The composite scores were non-normally distributed, an artifact of the overall high scores that respondents gave across all questions in the survey. All four composite variables had an average score of >75% of the maximum possible, indicating that respondents take action in their lives, engage in nature practices, believe that they have the characteristics and habits of problem-solvers, and believe that they are in a position to make a difference in their immediate community (Table 14). There were statistically significant correlations among all the composite variables with one another, whether using a parametric or non-parametric test (Table 15).

As with the similar analysis process for activities, respondents who had high scores in one composite variable had high scores in the other composite variables. While little nuance was revealed through this analysis, these results serve to highlight overall interconnectedness among participant perceptions of nature, community, and their competence in problem-solving.

Table 13. Composite variables for respondents, developed by converting Likert scales to numerical values and aggregating thematically related questions.

Composite Variable	Composite Variable Score Range	Qualtrics Survey Question Number and Text
Action Combined (combined value of the sub-composites listed below)	0-24	See sub-categories below

Action – community Actions related to influencing others within their immediate community	0-9	Q28_8: Share my science or nature knowledge with others (friends, family, peers, strangers). Q29_6: Finds ways to help family and friends when I can. Q30_14: Encourages friends and family members to do activities outdoors.
Action - env traditional Stereotypical or traditional actions associated with environmentalism	0-9	Q29_1: Participates in organized environmental stewardship and/or social justice activities. Q29_2: Signs online petitions for change (legislation, boycotts, etc.) Q29_3: Donates money to causes that are important to me.
Action - immediate control Environmental actions in areas of their life where participants have the autonomy to do so	0-6	Q29_4: Takes an active role in stewardship at home when I can (such as recycling, minimizing food waste, etc.). Q29_5: Thinks about environmental sustainability and ethical production when making purchases.
Nature Practice Combined (combined value of the sub-composites listed below)	0-48	See sub-categories below
Nature Practice - being outdoors Outside, nature-based activities	0-27	Q30_1: Spends time outdoors. Q30_10: Grows plants when I can. Q30_15: Takes short "nature breaks" during the day to refresh. Q30_17: Likes to exercise outdoors. Q30_4: Visits local parks or green spaces (including the beach). Q30_5: Visits parks and green spaces distant from where I live. Q30_6: Likes picnics, BBQs, and eating meals outside. Q30_7: Enjoys seeing wildlife. Q30_9: Goes camping or backpacking.
Nature Practice – belief Beliefs and feelings about nature	0-6	Q30_2: Finds nature a source of inspiration. Q30_3: Believes that access to nature can support health.
Nature Practice - indirect engagement Indirect nature-based practices that could be done without going outside or	0-15	Q30_11: Has nature apps on my phone. Q30_12: Likes to watch nature videos, shows, and films. Q30_13: Likes to learn how other cultures engage with nature.

interacting directly with plants or wildlife		Q30_16: Likes to work near a window with a view of the outdoors. Q30_8: Likes identifying the types of plants and wildlife I see.
Problem-solving disposition Characteristics and habits that are important components to being a problem-solver	0-27	Q28_1: Pay more attention to issues in the news. Q28_2: Notice more about my surroundings. Q28_3: See how issues connect or overlap. Q28_4: Consider multiple ways to approach a project or a problem. Q28_5: Identify things I would like to change in my neighborhood or community. Q28_6: Take time to think before I decide how to approach a project or problem. Q28_7: Feel more comfortable speaking to new people. Q29_10: Likes learning new things. Q29_7: Participates in creative work - like dance, art, craft, writing, or music.
Sense of Empowerment Characteristics and beliefs relating to sense of empowerment	0-30	Q29_8: Feels like I have a place in my community. Q29_9: Feels a sense of responsibility to my community. Q31_1: Have the power to make a difference in my family. Q31_2: Have the power to make a difference in my community. Q31_3: Can express myself through speaking and/or writing about an issue that is important to me. Q31_4: Can collaborate with others to accomplish a goal. Q31_5: Can lead a team to accomplish a goal. Q31_6: Can work on my own to accomplish a goal. Q31_7: Can recognize when I need to seek expertise from someone else in order to accomplish a goal. Q31_8: Can recognize the strengths I bring to a project.

Table 14. Descriptive statistics for the four composite variables.

	Action combined	Nature Practice combined	Problem-solving disposition	Sense of Empowerment
Sample size	65	65	65	65
Mean	18.169	38.123	23.185	24.769
Std. Deviation	3.827	6.999	3.097	3.678
Minimum	8.000	16.000	12.000	16.000
Maximum	24.000	48.000	27.000	30.000

Table 15. Correlation matrix for composite variables.

Composite Variable Comparison	Pearson		Spearman	
	r	p	rho	p
Action combined - Nature Practice combined	0.743***	< .001	0.711***	< .001
Action combined - Problem-solving disposition	0.618***	< .001	0.531***	< .001
Action combined - Sense of Empowerment	0.474***	< .001	0.475***	< .001
Nature Practice combined - Problem-solving disposition	0.587***	< .001	0.547***	< .001
Nature Practice combined - Sense of Empowerment	0.517***	< .001	0.519***	< .001
Problem-solving disposition - Sense of Empowerment	0.510***	< .001	0.509***	< .001

* p < .05, ** p < .01, *** p < .001

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