THESIS

EXPLORING THE RELATIONSHIP BETWEEN NORTHERN COLORADO SCIENCE TEACHERS' ENVIRONMENTAL AND PEDAGOGICAL VALUE ORIENTATIONS AND THEIR IMPLEMENTATION OF PLACE-BASED EDUCATION

Submitted by

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ABSTRACT

EXPLORING THE RELATIONSHIP BETWEEN NORTHERN COLORADO SCIENCE TEACHERS' ENVIRONMENTAL AND PEDAGOGICAL VALUE ORIENTATIONS AND THEIR IMPLEMENTATION OF PLACE-BASED EDUCATION

Place-based education (PBE) offers teachers a unique opportunity to increase engagement and academic outcomes while also strengthening students' connection to their environment and inspiring future stewardship. However, because PBE is not a required instructional tool, classroom teachers must independently choose to implement this teaching strategy, particularly when discussing topics surrounding wildlife and the environment. Thus, it is important for environmental education researchers to understand what drives teachers to pursue this pedagogical behavior. While there is a lack of direct predictive validity between values and behaviors, theory suggests that there is more to be found by exploring the value orientations of teachers and how that may influence their curricular choices. Using interviews with 11 middle and high school science teachers in Northern Colorado, we took a qualitative approach to assessing the relationship between teachers' value orientations – both environmental and pedagogical – and their perceptions of pedagogical behaviors. Through thematic coding and analysis, we discovered that Mutualist value orientations coincide with both an Ecological Integration approach to pedagogy and pedagogical behaviors that connect students with their environment, such as place-based education. Our findings have implications for the potential of place-based education to foster pro-environmental value orientations and behaviors among future generations.

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Introduction

Environmental education, both formal and informal, has long been considered a core opportunity to expand environmental literacy as students exposed to environmental education demonstrate not only a significant increase in their awareness of humans' relationship with the environment and wildlife but also a shift from an anthropocentric to ecocentric worldview (Goldman et al., 2013; Ballard et al., 2017). Other proponents of environmental education have also cited not only improved attitudes but also a shift in knowledge and pro-environmental behaviors, particularly among students who participated in outdoor, nature-based programs (Wells & Lekies, 2012; Duerden & Witt, 2010).

However, because nature-based programs are not always accessible or inclusive – due to limitations ranging from geographic location to cognitive-behavioral issues (Dupuis & Jacobs, 2021) – there have been movements to instead implement place-based education (PBE) in classrooms to achieve those same benefits. PBE is a process in which instructors use local communities or environments to contextualize broad or global topics that might be too abstract for students to grasp; this connects students to both their content and their communities, promoting civic engagement and an interdisciplinary approach to education (Semken et al., 2017; Wright et al., 2021). While PBE is a relatively new term, only appearing in recent decades, the concept has roots in the teaching philosophies and practices of indigenous peoples that emphasize pedagogy situated in local culture and environments (Semken et al., 2017). These philosophies were later adapted and presented in John Dewey's highly influential work "The School and Society," where he advocates for experiential learning in the local environment

(Woodhouse & Knapp, 2000). In this paper, we use the Wright et al. (2021) definition of PBE lessons as:

> Those that 1) are inspired by local cultural or biophysical context or issue, (2) allow school and community organizations or experts to collaborate, (3) integrate interdisciplinary content, (4) use inquiry and experiential pedagogy, and (5) are designed to encourage civic engagement. (p. 1520).

When successful, PBE can positively impact student engagement, civic learning, and academic outcomes (Gruenewald & Smith, 2014).

Because PBE is intrinsically linked to environmental literacy and sustainability, it has captured the attention of social scientists interested in its potential to foster future stewards of both the environment and wildlife in young generations. However, in order for that to be possible, classroom teachers must independently make the choice to implement this teaching strategy, particular when discussing topics pertaining to wildlife and the environment. While PBE lessons can be integrated into classrooms to meet Next Generation Science Standards (NGSS, i.e., content criteria shaping standardized curricula), PBE is not a requirement and teachers often do not have the support nor the agency to make the decision to incorporate new curricular approaches (Wright et al., 2021). Thus, it is important that social scientists identify what factors might change teachers' pedagogical behaviors and impact their decision to incorporate PBE into discussions of the environment and wildlife.

Theoretical Framework

Value-Attitude-Behavior hierarchy. Determining the drivers of pedagogical behaviors is challenging, as there remain conflicting explanations for what factors drive behaviors of teachers in their classrooms (Pruneau et al., 2006). A throughline across most candidate theories

is that teacher behaviors are ultimately rooted in values (Homer & Kahle, 1988; Borg, 2001). Values are an important component of people's *social cognition*, allowing us to not only process, retain, and utilize information but also direct our own behavior (Bulgarelli & Molina, 2016). More specifically, values can be described as the core beliefs that direct behaviors in people and in society; unlike other attributes (e.g., attitudes) that may shift to reflect different situations or environments, values are formed during youth and tend to remain steadfast across daily life (Manfredo et al., 2021). In his foundational work on values theory, Schwartz (1992) identified six main characteristics of values: i) they are inherently connected to a person's affect and linked to feelings; ii) they refer to goals that guide actions; iii) they are unchanging and do not shift to accommodate specific situations; iv) they serve as an individual's set of standards for evaluating other people, actions, or events; v) they are prioritized in importance relative to one another; vi) and this relative prioritization of multiple values is what drives action.

With these value definitions in mind, it is clear why an exploration of teachers' environmental values might be a critical factor in understanding their decision to integrate discussions of wildlife and the environment into their classrooms (Manfredo et al., 2016). However, there is a lack of empirical evidence for direct predictive validity between environmental values and pro-environmental behaviors, often referred to as the "value-action gap" (Kollmuss & Agyeman, 2002). This phenomenon is recognized as an explanation for when someone's actions do not coincide with their values. In response to this phenomenon, social psychologists have filled in the gap with other elements of social cognition such as attitudes and norms, theorizing that these other social cognitions play a mediating role in directing the relationship between values and behaviors (Schwartz, 1992).

This theory serves as the basis for the *value-attitude-behavior hierarchy* (Homer & Kahle, 1988); often described as an inverted pyramid (Figure 1), the hierarchy reflects values as a person's foundational attribute in their social cognition, reflecting their core beliefs. Their values then inform their attitudes, which in turn guide specific behaviors at the top of the pyramid (Fulton et al., 1996). One of the grounding interpretations of this theoretical framework was presented by Fulton et al. (1996) who – in identifying that values are a particularly abstract concept, making them difficult to link to the more tangible concept of behaviors – added the concept of value orientations to the hierarchy (Fulton et al., 1996). Value orientations refer to a set or pattern of basic beliefs about objects or situations, or a "world view," giving a more concrete meaning to abstract values (Whittaker et al., 2006). With value orientations added to the inverted pyramid, it not only emphasizes the feedbacks and interdependent relationships between each cognition level in the inverted pyramid, but also integrates the relative impacts of value orientations and behavioral intentions on behaviors (Figure 1). This adapted hierarchy, known also as the cognitive hierarchy of human behavior (Vaske & Donnelly, 1998) serves as the theoretical framing for this study. It asserts that teachers values inform their value orientations, which in turn inform their attitudes and norms, which influence their behavioral intentions, which ultimately their pedagogical behaviors or actions in their classroom.

Environmental value orientations. The introduction of value orientations allows for a more applied approach to values; while values may define a person's prioritization of qualities like honesty or achievement, value orientations can define patterns of beliefs about broad topics, such as nature (Whittaker et al., 2006). In fact, Fulton et al. (1996) also played a pivotal role in reimagining the ways in which people value wildlife specifically, identifying a spectrum between two main value orientations that people could have toward wildlife: mutualism and utilitarian.

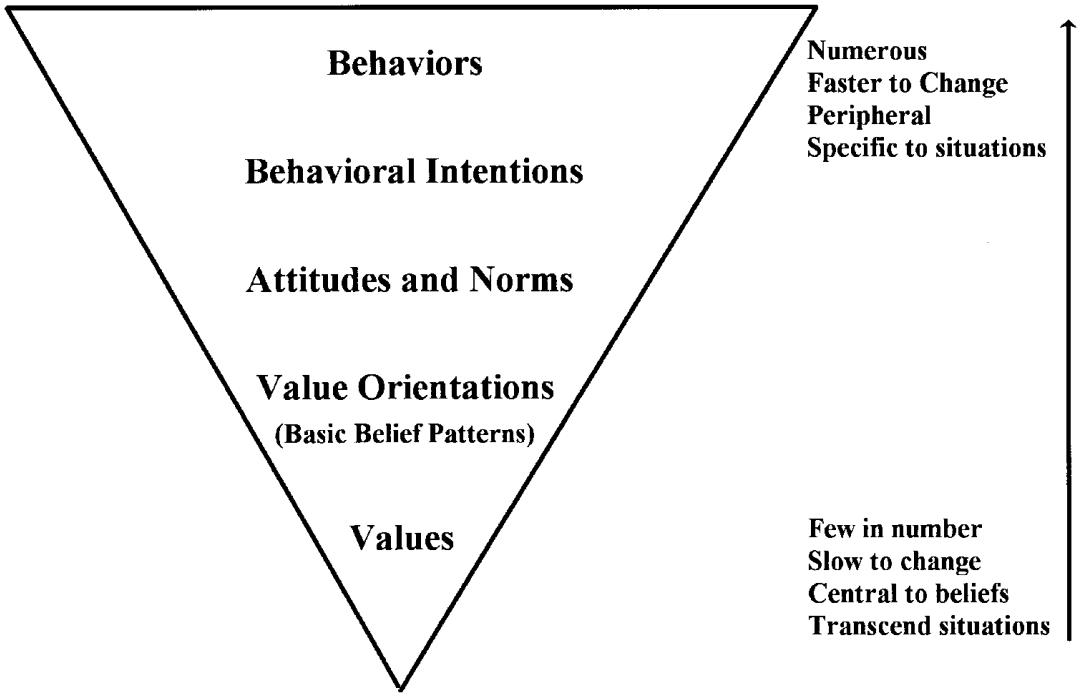

Figure 1. Vaske and Donnelly's (1998) cognitive hierarchy of human behavior, an expanded version of the values-attitudes-behavior sequence, serves as the theoretical framing for this study.

A *mutualism value orientation* views wildlife as living in harmony with humans, having basic rights, and deserving of compassion; the *utilitarian value orientation* views wildlife as something that should be used and managed for human benefit (Fulton et al., 1996).

In their *Wildlife Values in the West* regional report, Teel et al. (2005) advanced these ideas and used the mutualist-utilitarian spectrum to identify four unique value orientation types as they related to wildlife. Alongside the aforementioned utilitarian and mutualist value orientation types, they also define a *pluralist value orientation* as capable of having both a mutualist and utilitarian perspective toward wildlife. Someone with a pluralist value orientation means they may hold either value orientation depending on the situation, such as understanding and accepting the practice of hunting but choosing not to do it themselves for moral reasons (Teel et al., 2005). This value orientation type was named using the psychological concept of pluralism, which refers to a person's ability to hold multiple, sometimes conflicting, beliefs,

convictions, or interests (Cooper & McLeod, 2007). The final value orientation type is called a *distanced value orientation*, which describes holding neither the mutualist nor utilitarian value orientation and remaining disconnected from wildlife-related issues altogether (Teel et al., 2005).

Many scholars have taken the core ideologies of mutualism and utilitarianism and adapted them, such as defining value orientations on a continuum ranging from anthropocentric to biocentric while others use an egoistic-biospheric spectrum (Steel et al., 1994; De Groot & Steg, 2008). For the purposes of this paper, we will also be adapting them by using the mutualism-utilitarian dimensions and value orientations identified by Teel et al. (2005) but applying them more broadly to both wildlife and the environment as a whole. These will henceforth be referred to as a person's *environmental value orientation*, distinct from de Groot and Steg's (2008) definition.

Pedagogical value orientations. Just as a value orientations framework can be applied to an individual's relationship with the environment, it can also help describe the pedagogical choices that teachers make on a day-to-day basis. Social scientists already understand that one of the most important ways to instill a societal value for the environment is by targeting youth and fostering a connection to nature through nature-based education (Chawla, 2015). In particular, experiential learning and time spent in nature during one's youth, along with role models who demonstrate care for the natural world, have been proven to craft a value for the environment (Chawla, 2007; Owens & McKinnon, 2009; Nabhan & Trimble, 1994; Chawla & Derr, 2012). In fact, a study conducted by Chawla (2007) found that childhood experiences in nature and influential role models were the two most significant indicators of pro-environmental behavior in adulthood; five of her respondents even specifically mentioned teachers as their role models. Thus, understanding the factors behind teachers' decision to incorporate nature and the

environment into their curricula – such as through place-based education – has important implications for a future of pro-environmental young leaders. Further, previous studies have also identified how teachers' own values – conveyed through certain behaviors – can be transmitted to their students during schooling (Schmidt et al., 2019; Dietrich et al., 2015). For instance, a teacher's enthusiasm for a course subject has been shown to influence a student's value for it (i.e., student-perceived teacher enthusiasm) (Parrisius et al., 2020). However, as previously explained, the abstract nature of values and value systems, and the gap that exists between values and behaviors, make them particularly difficult to identify and measure (Whittaker et al., 2006). Thus, there is more to be found by exploring the value orientations of teachers and how that may influence their curricular choices.

In education research, there exists a separate inventory of value orientations that can be applied to classroom teachers and their pedagogy, henceforth referred to as an individual's *pedagogical value orientation*. Presently, most existing literature focuses on the value orientations of physical education teachers specifically and effectively categorizes their curricular decision-making accordingly (Ennis, 1992; Ennis & Chen, 1995; Chen et al., 1997). Unlike environmental value orientations, pedagogical value orientations are not placed on a spectrum that establishes various belief dimensions; however, they are still valuable for concisely describing patterns of beliefs that may result in specific behavioral choices. Pedagogical value orientations include Disciplinary Mastery, Learning Process, Self-Actualization, Social Responsibility, and Ecological Integration (Table 1).

This study aims to fill a gap by not only defining teachers environmental and pedagogical value orientations, but also exploring relationships between these value orientations and their pedagogical behaviors. Specifically, this study makes a contribution in applying Ennis's value

Table 1. Pedagogical Value Orientations as defined by Ennis (1992). Descriptions of value orientations adapted from Tan-Sisman & Ok (2012)

Pedagogical Value Orientations		Description
Disciplinary Mastery	(DM)	Places high priority on mastery of fundamental core knowledge and skills, gaining proficiency, cognitive understanding
Learning Process	(LP)	Prioritizes learning independently, problem solving skills
Self-actualization	(SA)	Emphasizes nurturing student growth, personal liberation
Social Responsibility	(SR)	Places high priority on societal needs and social change
Ecological Integration	(EI)	Puts emphasis on personal search for meaning by integrating natural and social environment

orientation theory beyond the education field focused on physical education. There is little to no information on how teachers' value orientations – both environmental and pedagogical – might relate to their decision to implement PBE in discussions of the environment, but it has important implications for shaping a generation of future environmental stewards. In this paper, we aim to take a novel approach to the cognitive hierarchy model of human behavior by exploring the relationship between Northern Colorado teachers' environmental and pedagogical value orientations and their own perceptions of how they teach about wildlife and the environment in their classrooms.

Methods

We took a qualitative approach to assessing the relationship between value orientations and perceptions of pedagogical behaviors using interviews with middle and high school science teachers from Northern Colorado. Grounding the study in qualitative interview data allowed us to first observe and make thematic interpretations of each participant's environmental value orientations through conversations about their personal relationship with the environment and wildlife, such as their exposure to nature during their upbringing. Similarly, open discussions about their classroom teaching strategies shed light on their pedagogical value orientations and their perceived pedagogical behaviors. The interview data was assessed for the degree to which

participants' environmental and pedagogical value orientations might influence their pedagogical behaviors (shown through the way they teach about environmental topics). It is worth noting that because interviews were the sole source of data, we are only able to assess teachers' *perceptions* of their own self-reported pedagogical behaviors rather than observe them ourselves.

Participant Recruitment

The first author reached out to 35 teachers, each of whom had a preexisting relationship or affiliation with co-authors M.B. and D.W. Fourteen of the teachers were affiliated with previous research implementing wildlife cameras in natural areas on or near school property, completed in 2019. The remaining 21 teachers are presently involved with Robert Noyce Teacher Scholarship Program, an NSF-funded project through which Drs. Balgopal and Wright are working to better understand the effectiveness of teacher preparation programs. Recruitment of participants occurred through email. Out of the 35 teachers that were contacted, 3 respondents were concluded to be improper fits for the study due to their subject matter, 5 had left the field of teaching due to retirement or other plans, and 16 did not respond. The remaining 11 teachers who agreed to participate represent 11 different schools and teach (or taught) grades ranging from 6-12 in subjects including biology, earth science, life science, outdoor education, environmental science, and chemistry (or a combination of these). All names of schools and teachers presented are pseudonyms.

Data Collection

From May-August of 2022, the 11 participating teachers were interviewed using a semi-structured interview protocol (Appendix) for an average total time of 1 hour per teacher. These interviews – all conducted remotely via Zoom except for one – were recorded with permission from the participant. Conversations focused on the participant's professional background,

personal interactions with wildlife and the environment across time, and their current teaching strategies, including the implementation of place-based education.

Thematic Coding

Each interview was transcribed using Otter.ai's live transcription software and then later cleaned by the first author to prepare for coding (Otter.ai, 2016) Once uploaded into MAXQDA – a qualitative data coding tool designed for mixed method analysis (Verbi Software, 2021) – segments of transcripts were categorized by the following broad themes: environmental value orientations (EVO), pedagogical value orientations (PVO), and pedagogical behaviors (PB). It is important to note that segments – or statements made in transcripts by participants – were coded, not individuals. Thus, we are not making assertions that a participant has a specific value orientation, but rather presenting how different statements they made could fit a certain value orientation and perceived behavior.

Participants' environmental value orientations (EVOs) were coded following procedures outlined in prior qualitative value orientation research that assigns participants into one of the four EVOs: mutualist, pluralist, utilitarian, or distanced (Dayer et al. 2007; McCoy et al. 2016) (Table 2). Coding protocols were adapted and implemented based on prior literature and study objectives to assign interview statements into specific EVOs (Thematic Codebook, Appendix). This step in the coding process was most relevant to parts of the interviews where participants were asked about their relationship with the environment as a whole and with wildlife specifically (Interview Protocol, Appendix). It is worth noting that while previous studies have categorized "Attraction/Interest" and "Concern for Safety" as belief dimensions that are separate from the four main EVO types (Dayer et al. 2007; Laverty et al. 2019), we chose to include these as part of the Mutualist and Distanced types, respectively (Table 2). These were the EVOs of

Table 2. Definitions[1] and Examples of Environmental Value Orientations (EVOs) and Dimensions Used for Coding

Value Orientation	Definition	Example
Mutualist *Feelings/Emotions* *Respect* *Spiritual/Therapeutic* *Attraction/Interest*[2]	View the natural world as capable of relationships with humans, as if part of an extended family, and as deserving of rights and care. They are less likely to support actions resulting in death or harm to wildlife, more likely to engage in pro-environmental behaviors, and more likely to view the natural world in human terms.	"You need to care for the land. That is your job. Not to try to conquer it, but to care for it." "Well, it has like this innate right to be here just like we do." "The closer to a natural environment or less manicured environment I feel the better" "They were very conscious of things like recycling" "[He] really wanted to see wolves while we were in Yellowstone"
Pluralist	Can hold both mutualist and utilitarian value orientations toward the natural world, meaning that which of the orientations plays a role is dependent on the situation. For certain issues, Pluralists are likely to respond in a manner similar to that of Utilitarians, whereas for other issues they may behave more like Mutualists.	"You know, I'm not a hunter. I value wildlife more for appreciating its beauty and its place. But, I also understand why we have hunting [and] all the management regulations and exactly how it can benefit wildlife in general as well." "I have mixed feelings…I was shocked by the amount of rabbits in Colorado, and that kind of conflicts with my gardening desire."
Utilitarian *Consumptive or abusive recreation* *Wildlife as nuisance*	Believe that the natural world should be used and managed primarily for human benefit. They are more likely to prioritize human well-being over the environment in their attitudes and behaviors. They are also more likely to participate in consumptive activities such as hunting or fishing and see wildlife as pests or a nuisance.	"Fishing is probably the closest I come to interacting with that type of wildlife." "My husband ended up killing the baby rattlesnake." "Moths are everywhere and I keep telling them 'Don't come into the apartment! You don't need to be in here!'"
Distanced *Lack of interest* *Concern for safety*[2] *Disgust*	Hold neither a mutualist or utilitarian orientation. As their label suggests, they tend to be less interested in wildlife and wildlife-related issues. More likely to express fear or disgust related to interacting with the natural world.	"I'm not very active with wildlife I'll say that much. It's just not something personally that I really got into." "I don't have that pull to want to go and be out in the wild." "I'm always kind of little on edge when I'm by myself out there." "I hate bugs…it's still so difficult for me to let stonefly nymphs crawl on my hands."

[1]Definitions adapted from McCoy et al. (2016) and Dayer et al. (2007)
[2]Belief dimensions identified by Dayer et al. (2007) as separate value orientations, but for the purposes of this paper were placed into category of best fit

best fit, as an attraction/interest toward the environment tends to correspond with a degree of care, and previous research found a higher level of concern for safety among Distanced individuals (McCoy et al. 2016).

Teachers' pedagogical value orientations (PVOs) were coded following procedures outlined in Ennis (1992) qualitative value orientation research that assigns participants into one of the five PVOs. However, because Ennis's PVOs had only ever been applied to physical education teachers, we used an adapted version of these categories to better fit middle and high school science teachers (Table 3). We used this step in the coding process primarily for portions of the interviews when we asked participants about their roles and practices as teachers (Interview Protocol, Appendix). In the preliminary review of each transcription, codes were first assigned to simply identify a teacher's pedagogical belief (such as their philosophies or goals) and pedagogical behaviors (their actual implementation of teaching strategies). From there, the pedagogical value orientations were deductively coded to a PVO of best fit – Disciplinary Mastery (DM), Learning Process (LP), Self-Actualization (SA), Social Responsibility (SR), and Ecological Integration (EI) (Table 3).

Lastly, the transcripts were inductively coded using an iterative process exploring trends pertaining to teachers' *self-perceived and self-reported* pedagogical behaviors (PBs) – such as their strategies, choices, or lesson plans in their classroom. This process followed a method outlined by Charmaz (2020) that aimed to "open inquiry rather than mold it into a previously established theoretical framework" (168). Once this iterative process was complete, PBs had been coded into one of the following themes: implementation of place-based education (PBE), benefits of PBE, Next-Generation Science Standards (NGSS) Disciplinary Core Idea, and NGSS Practice. Place-based education refers to any curricular choices that used "the local context as a

Table 3. Definitions and Examples of Pedagogical Value Orientations (PVOs) Used for Coding

Value Orientation	Definition	Example
Disciplinary Mastery (DM)	Prioritizes student mastery of fundamental knowledge, understanding, and skills. Discusses course content in the context of meeting state standards. Really wants students to be prepared for the following year.	"I think that you should make sure you're covering what needs to be covered." "Interpreting graphs is just a skill that they need to develop in middle school."
Learning Process (LP)	Prioritizes building skills like critical thinking and problem solving. Wants students to be able to think for themselves and come to their own conclusions. Focuses on the process of learning rather than grades or other academic outputs.	"We really do want them to think for themselves." "Giving them the tools to gather their own information and interpret the data and come to their own conclusions" "I think that it takes away from the learning experience to put so much emphasis on grades."
Self-Actualization (SA)	Emphasizes nurturing and empowering student growth as individuals. Recognizes students as people and makes sure their voices are heard. Focuses on the "big picture" and students gaining real-life skills for college and beyond.	"You want to inspire your students to see new paths in the future for them." "It's seeing them for who they are as a person individually." "Making sure that they're hearing everyone's voices…Especially middle school students really, really need that support."
Social Responsibility (SR)	Prioritizes students' role in civic engagement and social change. Relates course material to global issues. Wants to help students become good people through instilling in them qualities like respect and confidence.	"I can't save the world and the animals on my own, so let's inspire younger generations to do that with me." "Bringing that into the classroom expectations that we expect you to respect each other and everyone around you."
Ecological Integration (EI)	Integrates natural and social environment into course topics. Uses a more holistic approach to teaching by emphasizing experiential learning or other non-traditional practices to spark interest or passion. Caters course content to be more relevant or personal to students.	"I think students learn the most and are most engaged when you can incorporate their own interests." "There are some educators that can stand in front of the classroom all day and just talk and that is not me." "Since my first year, I was told that my strength was in building student relationships."

starting point to teach students about interconnected social-ecological systems with intentions to encourage civic engagement" (Wright et al. 2021, pp. 1519). This could include anything from using local weather patterns to discuss climate change or sampling macroinvertebrates from local river during an ecosystems unit. Segments that discussed *why* these PBE practices were valuable or important were coded separately into the second theme of "benefits of PBE."

The third and fourth PB themes used two of the three dimensions of learning described in the Next-Generation Science Standards ("Disciplinary Core Idea" and "Practice") to code PBs in terms of teachers' perceptions of how they chose to frame discussions of wildlife in the classroom. It is worth noting that the interviews did not involve any questions surrounding specific NGSS themes; these themes were simply used as a tool for categorizing PBs. For instance, if a teacher reported that they focused on "interconnectedness," we coded that statement to reflect the NGSS Disciplinary Core Idea of "Interdependent Relationships in Earth Systems." The first author coded a single interview transcript using this coding scheme, which was then used by one other researcher to code that same transcript. Inter-coder reliability among these two coders on the single interview transcript was determined to be 84%.

Thematic Analysis

To explore trends in teachers' value orientations and pedagogical behaviors, we used MAXQDA Visual Tools. First, we used the Code Matrix Browser to visualize the respective frequencies of EVO, PVO, and PB codes across individual participants. We then used the Code Relations Browser to look at co-occurrences in the data in order to better understand the relationships between value orientations and pedagogical behaviors. In MAXQDA, users can explore co-occurrences through one of the following: the intersection of codes in a segment, proximity of codes in the same document, or occurrence of codes in the same document. Our

codes rarely overlapped on a segment, and the occurrence of codes in the same document only indicates the number of documents in which codes co-occurred *at least once* (providing a maximum frequency of 11); thus, we chose to analyze our data using the proximity of codes in the same document. Because our longest interview transcript was 73 paragraphs, we chose to assess the frequency of codes that occurred within 73 paragraphs of one another – representing the frequency with which codes co-occurred in the same interview. In order to get the most thorough understanding of the relationship between value orientations – both environmental and pedagogical – and behaviors, we explored co-occurrence at each intersection of variables: EVOs vs. PVOs; EVOs vs. PBs; and PVOs vs. PBs.

Results

The most frequently-coded EVO, PVO, and PB across interviews were Mutualist, Ecological Integration, and the implementation of place-based education (PBE), respectively. Across all 11 interviews, the number of segments or passages coded for either an EVO, PVO, or pedagogical behavior ranged from 7 to 149 (Figure 2). Segments varied in length from a single word to a few lines of dialogue. Among EVOs, the highest number of segments were coded as Mutualist (149); similarly, Mutualist segments were found in all 11 interviews. By contrast, there were only 8, 11, and 31 segments that matched Pluralist, Utilitarian, and Distanced EVOs, respectively. Unlike the Mutualist segments, these three EVOs were also only found in at most 6 of the 11 interviews.

Among PVOs, the highest number of segments were coded as Ecological Integration (41) and, just like the Mutualist coding, these segments also occurred in all 11 interviews. The next-most common PVO was Learning Process (16 segments in 8 interviews). The Disciplinary

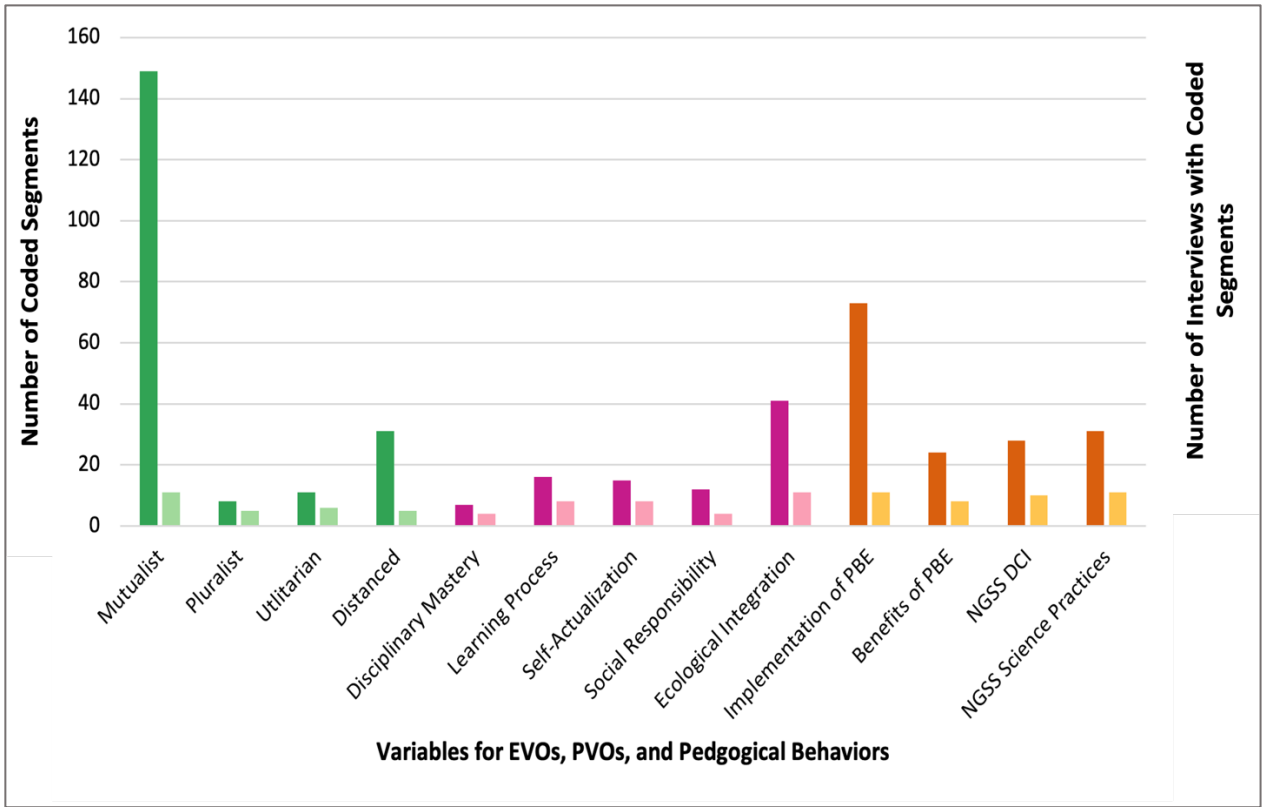

Figure 2. Frequencies of coded variables for EVO, PVO, and PB. Number of coded segments for EVOs (green), PVOs (magenta), and PBs (orange) and number of interviews with coded segments for EVOs (light green), PVOs (light pink), and PBs (yellow).

Mastery PVO only occurred in 7 segments across 4 interviews, making it the least frequent type of PVO found in our sample.

Finally, across PBs, the highest number of segments were coded as implementing PBE (73) which also aligns with Ecological Integration making up the highest number of PVO segments. Implementation of PBE took place across all 11 interviews. The only other pedagogical behavior to take place across all 11 interviews and in 31 segments was one of the three NGSS dimensions of learning, Science and Engineering Practices, which meant framing their lessons in a way that "describe[s] what scientists do to investigate the natural world" (NGSS Lead States 2013). While there are 8 of these Practices included in the standards, participants in this study primarily referenced three categories of Practice: "Asking Questions

and Defining Problems"; "Analyzing and Interpreting Data"; and "Engaging in Argument from Evidence."

Environmental Value Orientations

Coders were able to identify EVOs primarily using participant statements in response to questions such as: "How would you currently describe your relationship to the environment?" or "What do you think people gain, if anything, by interacting with the environment?" Out of the 11 teachers who participated in this study, 10 of them were most frequently coded with a Mutualist EVO (Figure 3). In fact, 3 of those 10 interviews – those of Maura, Natalie, and Janet – only had segments coded with a Mutualist EVO, meaning the only EVO that they expressed throughout their interviews were those of a Mutualist rather than including a mix of several EVOs like the others. Maura, Hannah, and Erin had the highest frequency of Mutualist coding, making 24, 21, and 19 mutualist statements in their interviews, respectively.

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Pluralist	1	1							2	2	2
Mutualist	15	11	24	19	21	7	5	9	15	12	11
Utilitarian		2		1	2			1	4		1
Distanced		1		11	5			13		1	

Figure 3. Frequency of EVO codes across participants. Frequencies for Pluralist (purple), Mutualist (green), Utilitarian (blue), and Distanced (pink) EVOs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

A common theme across the three participants with the highest frequency of Mutualist EVO coding was a feeling a *connection* to the environment as well as a *love* for wildlife. Maura, who enjoys mountain biking, hiking, camping, and dogs, stated "I love wildlife…[and] we've sought out ways to be connected with nature." Hannah, a rock climber, expressed a similar

sentiment, sharing, “There was always an innate love…I think that I feel a lot more spiritual connection in the mountains than I do in a church.” Finally, Erin, who spends her time playing board games and playing music, said, “Wildlife I've always felt pretty close to…I love animals and [they’re] easier at least for me to connect with.” Each of these 3 participants with high Mutualist codes used the exact same words “love” and “connection,” providing inside into some of the core characteristics of Mutualism.

In contrast, Marcia was the only participant who did not have Mutualist as her most frequently coded EVO, but rather Distanced. While she “appreciates” the natural world and sees it as “essential,” she more often expressed concern for safety given the risks of sharing a landscape with them. Again, because previous research linked higher levels of concern for safety with Distanced individuals, we chose to define statements this way as well. She stated, “I worry a lot more about mountain lions [here]…I walk a lot really late at night with my dog and I get a little bit more nervous about mountain lions.” Because she enjoys outdoor recreation in her free time, this concern for safety in a regular occurrence. As she explained, “I try and respect my distance with [mountain lions]…I’m very aware of my surroundings.” Further, while she assigns value to wildlife for its ecological importance, she also admits that wildlife is simply not an area of the utmost interest, which increased the frequency with which her interview was coded with a Distanced EVO. When asked about her relationship with wildlife, she admitted, “I’m not very active with wildlife, I'll say that much. It's just not something that I really got into…[but] I definitely view wildlife as essential. Obviously as a science educator I see the benefits of an ecosystem having a variety.” She appears to understand why wildlife is important, but she does not reflect the same “love” and “connection” that the Mutualist-oriented participants did.

Interestingly, while Erin was one of the participants who made the most frequent Mutualist statements (19), segments coded as Distanced were her second-most frequent (11). Unlike Marcia, rather than expressing a concern for safety when interacting with the natural world, Erin was more likely to convey a lack of interest in the environment or simply not prioritize spending time in nature. This was in contrast to her reporting a connection to wildlife and a "reverent" view of wildlife. When asked about her relationships with the environment during both her childhood and present day, Erin initially spoke about a connection with nature, as previously noted. However, with a bit more prying and assurance that there was no "right answer," she began to open up a bit more with statements that were coded as Distanced. For instance, she said, "I don't have that pull to want to go and be out in the wild…I gravitate a little more towards computers…Everyone [here] bikes, everyone hikes…and I'm like 'Can I read a book? Can I hide indoors where it's air conditioned?'" This desire to be separate from the natural world is a Distanced characteristic and is in direct conflict with her most frequently-coded EVO of Mutualist.

It is possible that the framing of the interview (such as our interest in her "relationship" with the environment) created social pressure for Erin to make more statements that were coded as Mutualist. Again, once reassured that we weren't looking for any specific answer, the number of Distanced statements began to increase. We place emphasis on this potential bias only because, while individuals are not limited to a single value orientation, it seems unlikely that someone would demonstrate a Mutualist EVO followed closely by a Distanced EVO. This highlights the complications of using our coding protocol on interview data, as all the information is self-reported and self-evaluated.

Pedagogical Value Orientations

Coders were able to identify PVOs primarily using participant statements in response to the broad question: "How would you describe yourself as a teacher?" An Ecological Integration PVO was the most frequently-coded PVO in 9 of the 11 transcripts were most frequently coded, however Janet's interview was the only one exclusively coded as such (Figure 4); notably, Janet was also one of the participants exclusively coded with a Mutualist EVO. In this study, the Ecological Integration PVO was primarily associated with experiential, hands-on learning that places the student at the center of the process. Some of the most frequently-used words to describe this pedagogy were: *excited, doing, hands-on, outside, passion,* and *connections.*

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Social Responsibility				1		2				8	1
Ecological Integration	4	5	2	3	2	2	4	3	4	7	5
Self-Actualization	1	1		1	4			2	3	2	1
Learning Process	1	1	1	3		1			1	4	4
Disciplinary Mastery		3							2	1	1

Figure 4. Frequency of PVO codes across participants. Frequencies for Social Responsibility (purple), Ecological Integration (green), Self-Actualization (blue), Learning Process (pink), and Disciplinary Mastery (orange) PVOs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

For the only two transcripts that were not coded with Ecological Integration as their most-frequent PVO – those of Erin and Jackie – Erin made an equal number of statements that were coded for Ecological Integration as she did for a Learning Process PVO (3), and Jackie was most-frequently coded for a Social Responsibility PVO (8). Jackie's statements centered around the idea that it was her moral duty to show her students how to care for the environment, while Erin focused on the importance of asking questions. For instance, Jackie shared, "I feel a responsibility for that, like this call to do more and do what I can and help open up the eyes of

students to even just realize their real impact on the environment every single day." Erin, on the other hand, stated that "[they] need to question the world around [them]." Jackie's emphasis on instilling a sense of responsibility in her students influenced her high frequency of Social Responsibility codes, while Erin was coded with a Learning Process PVO for her implementation of inquiry in the classroom.

Across all the interviews, the second-most commonly coded PVOs were Self-Actualization and Learning Process, and the least common PVOs were Disciplinary Mastery and Social Responsibility. Statements that were coded with a Disciplinary Mastery PVO often referenced a desire to hit the standards they were required to hit and to prepare students for future classes. For instance, just as Caroline shared, "I think that you should make sure you're covering what needs to be covered," Chloe said she "hit[s] every state standard, as I'm supposed to do. And then if I have that extra time, then I'll definitely throw in my little passion." These statements were often a direct result of an interview question about state standards.

Pedagogical Behaviors

Ten of the 11 teachers most frequently reported implementing place-based education as a PB (Figure 5). It is worth noting here that some participants were recruited from a pool of teachers who – at least at one point – actively implemented PBE through a wildlife camera trap program. They were also explicitly asked to "explain [their] understanding of place-based education and the role it may play in teaching" (Interview Protocol, Appendix). Thus, it is not remarkable that this was the most frequently-coded PB.

Janet (10), Caroline (9), Hannah (9), and Chris (9) spoke about implementing place-based education most frequently. When asked directly about how participants choose to implement PBE, some of the most commonly used words were: *outside, here, wildlife, around,* and

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Practice	4	1	2	3	2	2	7	1	4	3	2
Disciplinary Core Idea	5	2	1	0	1	2	1	2	1	10	3
Implementation	6	9	5	8	9	4	10	7	9	1	5
Importance/Benefits	2	2	0	4	0	2	2	3	0	6	3

Figure 5. Frequency of PB codes across participants. Frequencies for NGSS Practice Concepts (purple), NGSS Disciplinary Core Ideas (green), Implementation of PBE (blue), and Importance/Benefits of PBE (pink). PBs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

community. The ways in which the teachers implemented PBE varied greatly, particularly because of the different grade levels and subject matters. However, all of their implementation strategies involved using a local context to address core scientific topics such as weather, climate change, or food webs. Chris, for example, shared that "When I used to do weather…we used the flood from 2013 as our phenomenon and event that we kept coming back to help explain how that happened." Maura and Lynn, on the other hand, used their school's physical surroundings to integrate content. As Maura stated, "So where our school is located, there's a little community pond right across the street…We would take opportunities, mostly in ecology, where we would go to the pond [to] look at different plants around there and make observations." Lynn instead used the abundance of mule deer near her school's campus to "develop some lessons around looking at the mule deer population in Colorado and the impacts [of land use change] on that." These examples of PBE activities reflect the frequency of words like *here* and *around.*

Of the 10 teachers that most-frequently reported utilizing PBE as a PB, 8 of them also described the importance and benefits of using PBE when asked the role that PBE can play in student learning. Interestingly, while Jackie only described her own implementation of PBE once – citing her use of local wildlife cameras to discuss food webs – she also made the most comments on the *benefits* of PBE, explaining them on 8 occasions. In response to a question

asking about her current integration of PBE, she did explicitly state that she only uses PBE "some," but foresees using it "a lot more" in a new position that she's starting next year. For the participants who reported the benefits of PBE, they cited that the PB allows the content to be more relatable, engaging, meaningful, and effective in connecting students to their communities. While Jackie thought that "students are the most and are most engaged when you can incorporate their own interests," Erin believed that PBE "has more significance, and they remember [the content] better so it just it just works better on all levels." Marcia saw the benefits of PBE more simply, sharing, "My students just seem more excited in those settings." From the participants' perspectives, higher engagement and enthusiasm among the students were the primary benefits of PBE.

As previously stated, Jackie was the only participant who did not have PBE as their most frequently coded PB. While she did discuss PBE and its benefits, her most frequently-cited PB was situating discussions of the environment and wildlife through the lens of NGSS Disciplinary Core Ideas (DCI). Again, this category of PB was not self-reported in interviews in the same way that PBE was; instead, we found that using NGSS themes was conducive to categorizing other PBs that did not fit into the PBE themes. Split into Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering, Technology, and Applications of Science, DCIs are the key tools or organizing concepts that have broad importance in science (NGSS Lead States 2013). In Jackie's case, this referred mostly to two DCIs: "Interdependent Relationships in Earth Systems" and "Human Impact on Earth Systems."

The first DCI listed was relevant to discussions of food chains and the connected nature of ecosystems while the latter came up when teaching about topics such as environmental degradation or efforts to restore and conserve landscapes. Notably, these topics align with

Jackie's frequent Social Responsibility PVO. This DCI approach was found in 9 other interviews as well, just not with the same frequency as Jackie. In her classroom, she uses the DCI approach to learn "about ecology, food chains and food webs and understanding each organisms role in the environment and if we lose one it literally affects everything else in the environment." She also expressed wanting her students to "realize the impacts their actions have every day…so really trying to focus on action like now that we know this, what can we do? How can we positively contribute to the environment?" This reflects the DCI principles that ecosystems have interdependent relationships and humans can impact these mechanisms.

All of the 11 teachers cited behaviors that could be coded into the NGSS Science and Engineering Practices. For the first category of Practice, "Asking Questions and Defining Problems," participants highlighted their use of inquiry to promote student learning. Rather than making statements to the students, they chose to ask them questions. Interestingly, while this approach seems like it would overlap with a Learning Process PVO, there was not a strong pattern; in fact, Lynn made the most statements (6) that fit into this category of Practice, and she had 0 segments coded as Learning Process PVO. She shared that, in her classroom, "we look at [an experiment] and say, 'What did we learn?' And then, 'What questions do we have now?' That's an approach that I use all the time." Her inquiry-based approach aligns with the first category of Practice, but did not coincide with a Learning Process EVO.

The second category of Practice, "Analyzing and Interpreting Data," was used by the greatest number of participants (5) – Janet, Chris, Jackie, Maura, and Chloe. For this PB, the teachers emphasized having their students look at graphs and data in order to deliver scientific topics. For example, while Jackie focused on "teaching them how do we interpret graphs, like what is this data showing us? And kind of like, letting them come to their own conclusions,"

Chris shared that, “One of the lessons we did [on climate change] is we looked at 10 different sets of long term data and all they had to do is interpret the data. Well, what's happening here, you know, as CO2 increases, temperature was increasing.” By simply providing the students with data and giving them the independence to perform analysis and draw conclusions, these participants effectively implemented the “Analyzing and Interpreting Data” Practice.

The final category of Practice, “Engaging in Argument from Evidence,” primarily came up during interviews when participants were asked about how they handle discussions of “controversial” environmental topics. They spoke of using those opportunities to instill in their students the ability to collect and organize evidence into a coherent argument, rather than simply telling students what is “right” or “wrong.” Chris shared that he will often push back: “Usually when I get challenged, I usually ask them [to] prove it. Use the data to prove your point.” Lynn shared a similar sentiment, stating that “if [the students are] going to make a claim or statement about something like, ‘I think hunting is good,’ [they] need to back it up and tell us why. [They] need to provide some reasoning and justify that statement.” In doing so, whether deliberately or not, these teachers build student skills by integrating the “Engaging in Argument from Evidence” Practice.

Value Orientations’ Relation to Behaviors

In exploring the relationship between teachers’ value orientations and their pedagogical behaviors, it was important to look at co-occurrences within each document at intersections between EVOs, PVOs, and PBs.

Environmental Value Orientation x Pedagogical Value Orientation. The greatest frequency of proximal co-occurrence of codes (190) existed between a Mutualist EVO and an Ecological Integration PVO (Figure 6). In other words, segments coded for a Mutualist EVO

occurred within the same a document as segments coded for an Ecological Integration PVO a total of 190 times. The second and third highest frequencies of co-occurrence between codes (128, 130) were between Mutualist EVO codes and codes for both a Learning Process and Self-Actualization PVO. The lowest frequencies of co-occurrence were 4 and 6, which were present between the Utilitarian EVO and Social Responsibility PVO and the Distanced Evo and Disciplinary Mastery PVO, respectively. The Mutualist EVO had the highest average frequency of co-occurrence with PVOs (mean: 112.8); this makes sense as the Mutualist EVO was coded the most frequently across transcripts and was present in all 11 interviews.

		Pedagogical Value Orientation				
		Social Responsibility	Ecological Integration	Self-Actualization	Learning Process	Disciplinary Mastery
Environmental Value Orientation	Pluralist	13	33	16	19	14
	Mutualist	61	190	128	130	55
	Utilitarian	4	33	23	17	13
	Distanced	21	51	41	21	6

Figure 6. Co-occurrence of EVOs and PVOs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies.

Pedagogical Value Orientation x Pedagogical Behavior. When looking at the relationship between participants' PVOs and PBs (Figure 7), the most-frequent co-occurrence existed between codes for an Ecological Integration PVO and the implementation of place-based education (114). These two variables co-occurred more than 1.5x more frequently as even the second-most common co-occurrence, which was present between an Ecological Integration PVO and the PB of NGSS Practice concepts. The lowest frequencies of co-occurrence (16, 17) were found between the Disciplinary Mastery PVO and both the use of NGSS Practice concepts as well as the importance of place-based education, respectively.

		Pedagogical Behavior			
		Practice	Disciplinary Core Idea	Implementation	Importance/Benefits
Pedagogical Value Orientation	Social Responsibility	22	26	30	27
	Ecological Integration	72	66	114	57
	Self-Actualization	35	38	69	28
	Learning Process	37	37	63	33
	Disciplinary Mastery	17	23	31	16

Figure 7**.** Co-occurrence of PVOs and PBs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies. "Practice" and "Disciplinary Core Idea" headings refer to NGSS dimensions, while "Implementation" and "Importance/Benefits" headings refer to place-based education (PBE).

Environmental Value Orientation x Pedagogical Behavior. The greatest frequency of proximal co-occurrence of codes (222) existed between a Mutualist EVO and the implementation of PBE, followed by the co-occurrence of a Mutualist EVO and the PB of NGSS Practice concepts (180) (Figure 8). Again, the Mutualist EVO had the highest average frequency of co-occurrence with a mean frequency of 168.25 across all four PBs. The lowest frequency of co-occurrence (17) was found between a Utilitarian EVO and the importance of PBE. In fact, the PB reflecting the importance of PBE had the lowest mean frequency of co-occurrence with EVOs, averaging only 47.5 co-occurrences across the four EVOs.

		Pedagogical Behavior			
		Practice	Disciplinary Core Idea	Implementation	Importance/Benefits
Environmental Value Orientation	Pluralist	22	29	38	19
	Mutualist	180	158	222	113
	Utilitarian	24	19	58	17
	Distanced	41	35	65	41

Figure 8**.** Co-occurrence of EVOs and PBs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies. "Practice" and "Disciplinary Core Idea" headings refer to NGSS dimensions, while "Implementation" and "Importance/Benefits" headings refer to place-based education (PBE).

Discussion

By exploring the value orientations and behaviors of science teachers in Northern Colorado, we discovered that Mutualist ideologies coincide with both an Ecological Integration approach to pedagogy and perceived pedagogical behaviors that connect students with their environment, specifically place-based education. Looking at each of these variables conceptually, it makes sense that there would be patterns between these two types of value orientations and the implementation of PBE. A Mutualist EVO has been shown to emphasize feelings of connection to and affection for the natural world. For these participants, all 11 reported positive experiences relating to the natural world during their childhood, often before we even asked about this relationship. These positive experiences ranged from camping and hiking with friends to visiting zoos and wildlife refuges, and each were cited as contributing to their positive relationship with the environment as adults (e.g., "[My brothers and I] were outside every day…I would say it had a huge impact on me").

Just as it is widely understood that positive experiences in nature can promote pro-environmental values and attitudes (DeVille et al., 2021; Jensen & Olsen, 2019), all the teachers in this study reported foundational experiences in nature and were each coded – to varying frequencies – with a Mutualist EVO. This speaks to the role that these nature experiences during adolescence might play in shaping their value orientations. This is an important trend because, with value orientations being an understudied component of the cognitive hierarchy, not much is known about what drives the formation of environmental value orientations. Ewert et al. (2005) has made the argument that early childhood experiences in nature contribute to the formation of pro-environmental values, and our findings suggest that this same type of relationship might exist for the formation of Mutualist EVOs as well.

Because individuals with a Mutualist EVO have an affinity towards the natural world, it logically tracks that *educators* with a Mutualist EVO would have a pedagogical worldview that incorporates their environment, such as through an Ecological Integration PVO. In our case, an Ecological Integration PVO was the most frequently coded and was present across all 11 participants, just as the Mutualist EVO was. In fact, the word "connection" was found to be one of the highest-frequency terms used among both the Mutualist EVO and the Ecological Integration PVO; if nothing else, this speaks to a compatibility between these two value orientations. Just as each teacher conveyed a Mutualist EVO by describing their personal experiences in nature during their childhood, they also each demonstrated an Ecological Integration PVO by discussing their desire to take students outside into the natural world to have those same experiences.

This desire for those with positive outdoor experiences to take students outside for those same experiences reflects findings from Bergmark et al. (2018) who found that one of the strongest motivators in teachers' decision-making was to *recreate* their own positive experiences from being in school. This was shown to be the case for 3 of our participants with the highest frequency of an Ecological Integration PVO; their motivation to connect students with the environment was explicitly driven by their own experience with a teacher or mentor who facilitated hands-on learning in nature and instilled passion for the outdoors (e.g., "[My teacher] just got kids excited about nature and science and I wanted to be able to do something similar."). These findings not only support previous literature stating that experiences in nature and positive role models are important drivers in creating a connection to nature (Chawla 2007), but also provide novel insight into the relationship between teachers' environmental and pedagogical value orientations.

This relationship between a Mutualist EVO and Ecological Integration PVO is important because it appears to manifest itself in pedagogical behaviors that allow for experiential, hands-on learning through PBE. Just as both the Mutualist EVO and the Ecological Integration PVO emphasize connections to the environment, the pedagogical behavior of implementing PBE also appears to be based in this theme of connections. One of the reasons that PBE is gaining traction in the field of education is that it allows students to connect with the course material by linking it to their lived experiences in their local community (Sobel 2004; Deringer 2017). If a teacher develops a connection to the natural world through lived experiences in their local community, as our participants did, it is supported by literature that they would want to recreate those same experiences as a teacher (Hahl & Mikulec, 2018; Farrell & Lim, 2005), developing both a pedagogical value orientation and actual pedagogical behaviors that emphasize fostering those same types of connections. In our case, the development of an Ecological Integration PVO through lived experiences could have led to our participants' pedagogical behaviors such as participating in PBE workshops, applying to be a Noyce Scholar, and agreeing to participate in this study; each of these choices aligns with an Ecological Integration PVO and to the pedagogical behavior of going above and beyond in an effort to connect students to their environment.

Limitations and Further Studies

As previously stated, the participants in this study were recruited from a group that has an existing relationship with co-authors M.B. and D.W. from being involved in place-based education workshops or the Noyce Scholars program. Because of this, it was unlikely that we would find relationships between value orientations and the decision to *not* implement PBE. Along the same lines, participants were specifically prompted about their use of PBE in the

classroom. With this paper serving as a preliminary exploration of the potential links between value orientations and pedagogical behaviors within a very specific study population, future studies would benefit from recruiting from a more diverse set of teachers that may or may not implement PBE.

There is also more to learn by exploring an individual's ability to hold multiple value orientations. While the Mutualist EVO and Ecological Integration PVO certainly made up the majority of coded segments in their respective categories, our participants were often coded for multiple EVOs and PVOs. Erin, as previously addressed, is a particularly interesting example of this as she was coded with a Distanced EVO in close second to a Mutualist EVO. Future research might explore: What are some of the boundaries on an individual's ability to hold more than one value orientation? Do these differing value orientations exist in a hierarchy, or are they situation-specific? In the quantitative studies exploring environmental value orientations that initially inspired this study (Teel et al. 2005; Manfredo et al. 2018), these questions were left unanswered because value orientations were determined by using a single "mutualist-utilitarian" continuum measured by the degree of agreement with a number of statements (Whittaker et al. 2006). In this study, however, *segments* were categorized into value orientations rather than *participants* themselves, and there were too many assumptions in place to categorize participants into a value orientation based solely on their frequency of certain codes. In the future, it would perhaps be more beneficial to attempt to quantify the relative strengths or weights of each value orientation in influencing behaviors.

Further, while values are understood to be relatively static or at most slow to change, future research could investigate if value orientations may be more malleable or situation-specific. One theory for our participants' ability to convey more than one value orientation is that

they were projecting an array of value orientations they have held throughout their lifetime. Using Erin as an example again, many of her Mutualist statements were said in the context of her adolescent relationship with the environment; however, when speaking about her current relationship, she made more statements coded with a Distanced EVO. Rather than holding more than one value orientation, this instead may simply reflect a *shift* in her value orientation. Similarly, Caroline made 3 statements coded for a Disciplinary Mastery PVO and 5 for an Ecological Integration PVO. On the surface, this reflects multiple PVOs; however, in the greater context of her interview, she explained that her long teaching career has allowed her to navigate obstacles to PBE such as state standards or future course preparation. This theory of shifting value orientations can be backed by a study among Turkish youth from 1989 to 1995; over the course of 6 years, the value orientations of the sample population shifted away from self-realization (e.g., honesty, open-mindedness) and toward competition (e.g., ambition, capability) (Çileli 2000). Future research could build upon this theory by exploring not only how teachers' value orientations form and shift over time, but also the relative strengths with which they might drive behaviors in classroom teachers.

Study Implications

Our findings can contribute to environmental and sustainability education because they have implications for the potential of place-based education to foster pro-environmental affects and behaviors among future generations. By exploring how environmental and pedagogical value orientations might relate to the pedagogical behaviors of science teachers in Northern Colorado, we implemented a novel approach to the cognitive hierarchy of human behavior outlined by Vaske and Donnelly (1998). While there are still unknowns in the gap between value orientations and behaviors – such as the effects of intermediate cognitions like attitudes or

behavioral intentions – our findings contribute to education research by uncovering a relationship between Mutualist worldviews, an Ecological Integration approach to pedagogy, and pedagogical behaviors that connect students with their environment. Importantly, each of our participants not only cited experiences interacting with the environment during their youth but also specifically highlighted experiences relevant to their local community; now as adults, they demonstrate a predominantly Mutualist EVO as well as a desire to offer nature-based experiences for their students through place-based education. In other words, as children, these participants formed connections to their local community and now, as adults, their value orientations reflect the persistence of that connection. Further, they take intentional action through PBE to try to pass that same connection along to their students, which findings suggest could manifest itself as a Mutualist EVO later in life. Results from this study can further contribute to supporting the benefits of place-based education by highlighting their potential ability to shape student value orientations by connecting them to their local environment. As evidenced by the cognitive hierarchy of human behaviors, these value orientations could then result in pro-environmental behaviors among future generations, thus advancing global conservation efforts on the large scale.

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APPENDIX

Table A1. Pedagogical Value Orientations as defined by Ennis (1992). Descriptions of value orientations adapted from Tan-Sisman & Ok (2012)

Pedagogical Value Orientations		**Description**
Disciplinary Mastery	(DM)	Places high priority on mastery of fundamental core knowledge and skills, gaining proficiency, cognitive understanding
Learning Process	(LP)	Prioritizes learning independently, problem solving skills
Self-actualization	(SA)	Emphasizes nurturing student growth, personal liberation
Social Responsibility	(SR)	Places high priority on societal needs and social change
Ecological Integration	(EI)	Puts emphasis on personal search for meaning by integrating natural and social environment

Table A2. Definitions[1] and Examples of Environmental Value Orientations (EVOs) and Dimensions Used for Coding

Value Orientation	Definition	Example
Mutualist *Feelings/Emotions* *Respect* *Spiritual/Therapeutic* *Attraction/Interest*[2]	View the natural world as capable of relationships with humans, as if part of an extended family, and as deserving of rights and care. They are less likely to support actions resulting in death or harm to wildlife, more likely to engage in pro-environmental behaviors, and more likely to view the natural world in human terms.	"You need to care for the land. That is your job. Not to try to conquer it, but to care for it." "Well, it has like this innate right to be here just like we do." "The closer to a natural environment or less manicured environment I feel the better" "They were very conscious of things like recycling" "[He] really wanted to see wolves while we were in Yellowstone"
Pluralist	Can hold both mutualist and utilitarian value orientations toward the natural world, meaning that which of the orientations plays a role is dependent on the situation. For certain issues, Pluralists are likely to respond in a manner similar to that of Utilitarians, whereas for other issues they may behave more like Mutualists.	"You know, I'm not a hunter. I value wildlife more for appreciating its beauty and its place. But, I also understand why we have hunting [and] all the management regulations and exactly how it can benefit wildlife in general as well." "I have mixed feelings…I was shocked by the amount of rabbits in Colorado, and that kind of conflicts with my gardening desire."
Utilitarian *Consumptive or abusive recreation* *Wildlife as nuisance*	Believe that the natural world should be used and managed primarily for human benefit. They are more likely to prioritize human well-being over the environment in their attitudes and behaviors. They are also more likely to participate in consumptive activities such as hunting or fishing and see wildlife as pests or a nuisance.	"Fishing is probably the closest I come to interacting with that type of wildlife." "My husband ended up killing the baby rattlesnake." "Moths are everywhere and I keep telling them 'Don't come into the apartment! You don't need to be in here!'"
Distanced *Lack of interest* *Concern for safety*[2] *Disgust*	Hold neither a mutualist or utilitarian orientation. As their label suggests, they tend to be less interested in wildlife and wildlife-related issues. More likely to express fear or disgust related to interacting with the natural world.	"I'm not very active with wildlife I'll say that much. It's just not something personally that I really got into." "I don't have that pull to want to go and be out in the wild." "I'm always kind of little on edge when I'm by myself out there." "I hate bugs…it's still so difficult for me to let stonefly nymphs crawl on my hands."

[1]Definitions adapted from McCoy et al. (2016) and Dayer et al. (2007)
[2]Belief dimensions identified by Dayer et al. (2007) as separate value orientations, but for the purposes of this paper were placed into category of best fit

Table A3. Definitions and Examples of Pedagogical Value Orientations (PVOs) Used for Coding

Value Orientation	Definition	Example
Disciplinary Mastery (DM)	Prioritizes student mastery of fundamental knowledge, understanding, and skills. Discusses course content in the context of meeting state standards. Really wants students to be prepared for the following year.	"I think that you should make sure you're covering what needs to be covered." "Interpreting graphs is just a skill that they need to develop in middle school."
Learning Process (LP)	Prioritizes building skills like critical thinking and problem solving. Wants students to be able to think for themselves and come to their own conclusions. Focuses on the process of learning rather than grades or other academic outputs.	"We really do want them to think for themselves." "Giving them the tools to gather their own information and interpret the data and come to their own conclusions" "I think that it takes away from the learning experience to put so much emphasis on grades."
Self-Actualization (SA)	Emphasizes nurturing and empowering student growth as individuals. Recognizes students as people and makes sure their voices are heard. Focuses on the "big picture" and students gaining real-life skills for college and beyond.	"You want to inspire your students to see new paths in the future for them." "It's seeing them for who they are as a person individually." "Making sure that they're hearing everyone's voices…Especially middle school students really, really need that support."
Social Responsibility (SR)	Prioritizes students' role in civic engagement and social change. Relates course material to global issues. Wants to help students become good people through instilling in them qualities like respect and confidence.	"I can't save the world and the animals on my own, so let's inspire younger generations to do that with me." "Bringing that into the classroom expectations that we expect you to respect each other and everyone around you."
Ecological Integration (EI)	Integrates natural and social environment into course topics. Uses a more holistic approach to teaching by emphasizing experiential learning or other non-traditional practices to spark interest or passion. Caters course content to be more relevant or personal to students.	"I think students learn the most and are most engaged when you can incorporate their own interests." "There are some educators that can stand in front of the classroom all day and just talk and that is not me." "Since my first year, I was told that my strength was in building student relationships."

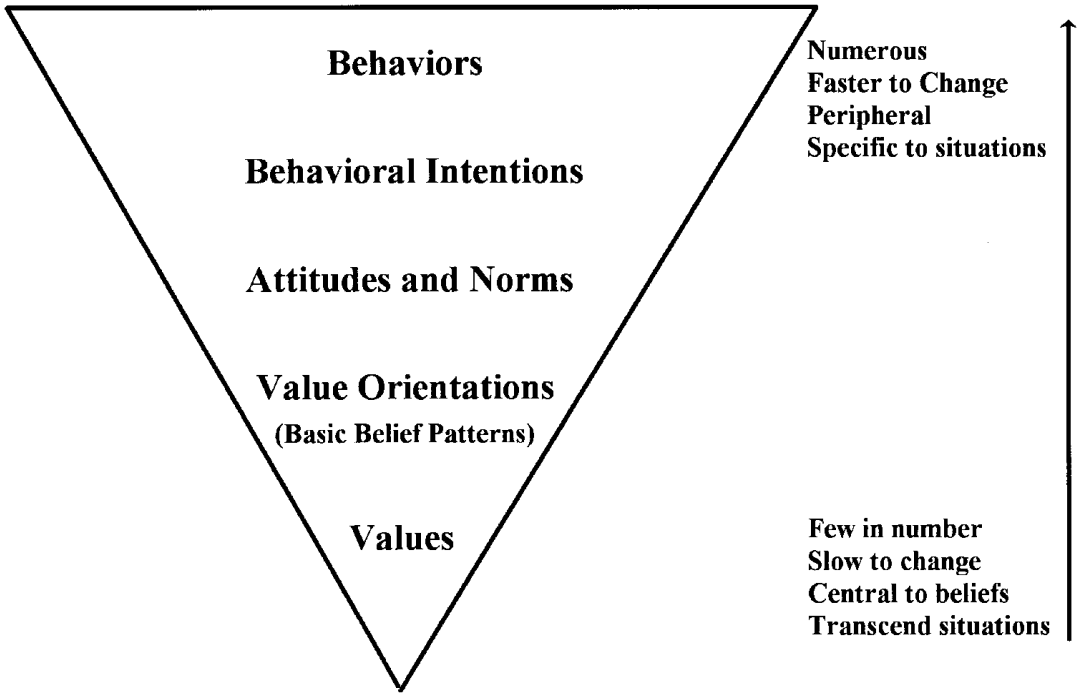

Figure A1. Vaske and Donnelly's (1998) cognitive hierarchy of human behavior, an expanded version of the values-attitudes-behavior sequence, serves as the theoretical framing for this study.

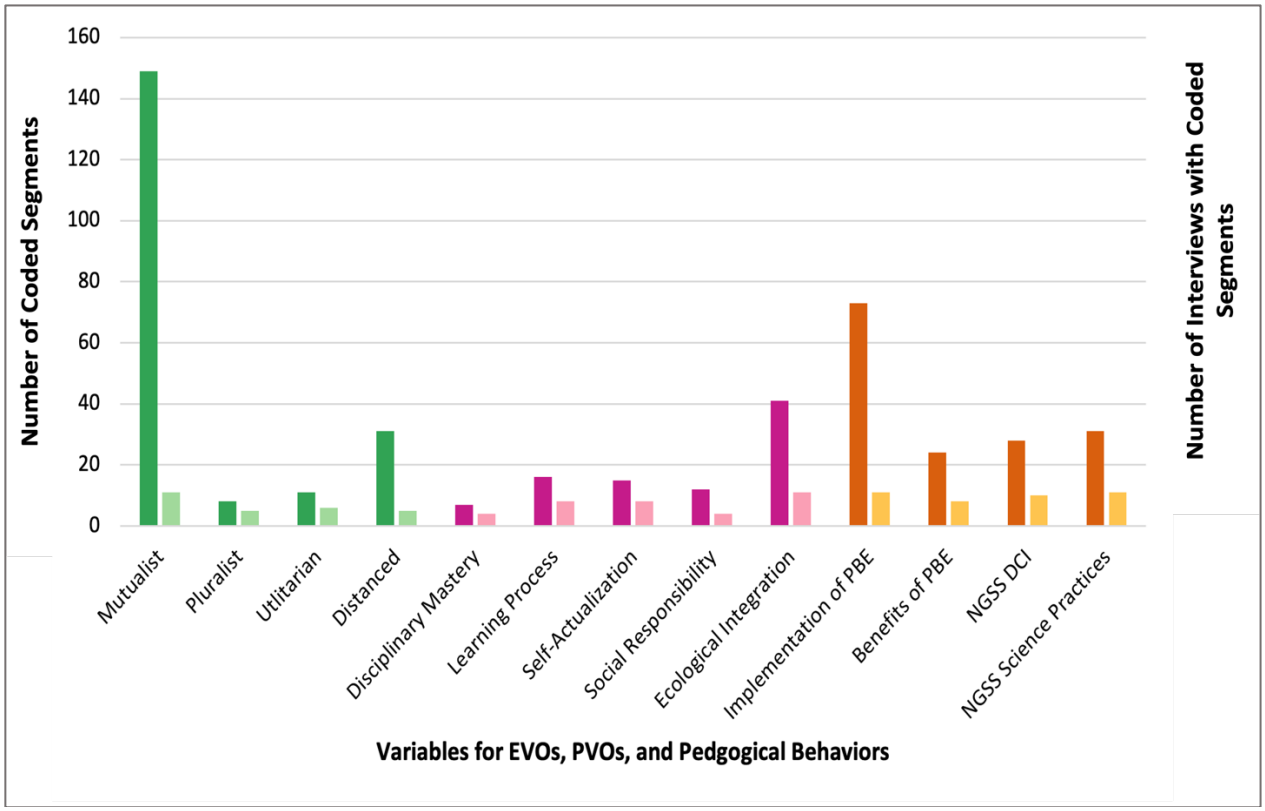

Figure A2. Frequencies of coded variables for EVO, PVO, and PB. Number of coded segments for EVOs (green), PVOs (magenta), and PBs (orange) and number of interviews with coded segments for EVOs (light green), PVOs (light pink), and PBs (yellow).

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Pluralist	1	1							2	2	2
Mutualist	15	11	24	19	21	7	5	9	15	12	11
Utilitarian		2		1	2			1	4		1
Distanced		1		11	5			13		1	

Figure A3. Frequency of EVO codes across participants. Frequencies for Pluralist (purple), Mutualist (green), Utilitarian (blue), and Distanced (pink) EVOs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Social Responsibility				1		2				8	1
Ecological Integration	4	5	2	3	2	2	4	3	4	7	5
Self-Actualization	1	1		1	4			2	3	2	1
Learning Process	1	1	1	3		1			1	4	4
Disciplinary Mastery		3							2	1	1

Figure A4. Frequency of PVO codes across participants. Frequencies for Social Responsibility (purple), Ecological Integration (green), Self-Actualization (blue), Learning Process (pink), and Disciplinary Mastery (orange) PVOs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

	Lynn	Caroline	Maura	Erin	Hannah	Natalie	Janet	Marcia	Chris	Jackie	Chloe
Practice	4	1	2	3	2	2	7	1	4	3	2
Disciplinary Core Idea	5	2	1	0	1	2	1	2	1	10	3
Implementation	6	9	5	8	9	4	10	7	9	1	5
Importance/Benefits	2	2	0	4	0	2	2	3	0	6	3

Figure A5. Frequency of PB codes across participants. Frequencies for NGSS Practice Concepts (purple), NGSS Disciplinary Core Ideas (green), Implementation of PBE (blue), and Importance/Benefits of PBE (pink). PBs are displayed using both numbers and color gradients in which darker colors represent a higher frequency of coded segments.

		Pedagogical Value Orientation				
		Social Responsibility	Ecological Integration	Self-Actualization	Learning Process	Disciplinary Mastery
Environmental Value Orientation	Pluralist	13	33	16	19	14
	Mutualist	61	190	128	130	55
	Utilitarian	4	33	23	17	13
	Distanced	21	51	41	21	6

Figure A6. Co-occurrence of EVOs and PVOs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies.

		Pedagogical Behavior			
		Practice	Disciplinary Core Idea	Implementation	Importance/Benefits
Pedagogical Value Orientation	Social Responsibility	22	26	30	27
	Ecological Integration	72	66	114	57
	Self-Actualization	35	38	69	28
	Learning Process	37	37	63	33
	Disciplinary Mastery	17	23	31	16

Figure A7**.** Co-occurrence of PVOs and PBs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies. “Practice” and “Disciplinary Core Idea” headings refer to NGSS dimensions, while “Implementation” and “Importance/Benefits” headings refer to place-based education (PBE).

		Pedagogical Behavior			
		Practice	Disciplinary Core Idea	Implementation	Importance/Benefits
Environmental Value Orientation	Pluralist	22	29	38	19
	Mutualist	180	158	222	113
	Utilitarian	24	19	58	17
	Distanced	41	35	65	41

Figure A8**.** Co-occurrence of EVOs and PBs. Frequencies with which coded segments occur within the same document are displayed by a numerical value as well with a gradient with dark blue representing high frequencies and light blue representing low frequencies. “Practice” and “Disciplinary Core Idea” headings refer to NGSS dimensions, while “Implementation” and “Importance/Benefits” headings refer to place-based education (PBE).

Semi-structured Individual Protocol

1. Can you please introduce yourself, your background, experience and knowledge around wildlife biology, and describe your position/role at your school?
    a. How would you say your background has led you to where you are now?
2. How would you describe your interactions with the environment during your *childhood*?
    a. How did your family/friends/community engage with nature, if at all?
3. How would you *currently* describe your relationship to the environment?
    a. How would you describe your feelings about wildlife specifically?
    b. What do you think people gain, if anything, by interacting with the environment?
4. What are your perceptions of wildlife relevant to your local community?
5. How would you describe yourself as a teacher (teaching styles, strengths, etc.)?
6. Explain your understanding of place-based education and the role it may play in teaching
7. Can you help me understand how *your* ideas about PBE developed? (e.g., from your personal experiences, hobbies, or education)?
8. Do you currently integrate PBE into your curricula, and if so, can you describe these?
9. How do you integrate discussion of socio-scientific issues into your curriculum?
10. How do you choose to frame these socio-scientific issues to your students?
11. How do you integrate discussion of local wildlife into your curriculum?
12. How do you choose to frame topics of wildlife to your students?
13. By your own evaluation, to what extent, if any, would you say your own experiences and perceptions about the environment and wildlife influence how you teach about these topics?

Thematic Codebook

Theme	Sub-Theme	Sub-sub Theme	Definition	Example
Environmental Value Orientation	Mutualist		View the natural world as capable of relationships with humans, as if part of an extended family, and as deserving of rights and care. They are less likely to support actions resulting in death or harm to wildlife, more likely to engage in pro-environmental behaviors, and more likely to view the natural world in human terms.	"You need to care for the land. That is your job not to try to conquer it. But to care for it." “They were very conscious of things like recycling”
		Feelings/Emotions	Describes the natural environment using language involving positive feelings or emotions toward it, such as expressing care or affection for it	"I just fell in love with nature out here" "There was always an innate love [for nature]"
		Respect	Sees the natural world through a lens of admiration and reverence. May be more likely to advocate for a "hands-off" approach to the environment out of respect for it	"these creatures are just trying to survive it's not my place to come in and interfere" "It's kind of like nice to share space with wildlife. And I think I have a respect for it."
		Spiritual/Therapeutic	Emphasizes feeling a *connection* to the environment and expresses how spending time or reflecting in the natural world can improve their mood, stress, or mental health	"If it was a bad day [or] something that upset me the way I worked it out was by going outside and being outside" "There's an inherent connection [to the wild] there"
		Attraction/Interest	Demonstrates overall fascination and interest in the natural world or a desire to engage more	“[He] really wanted to see wolves while we were in Yellowstone” "I've always been fascinated with wild cats in particular like large cats"
	Pluralist		Can hold both mutualist and utilitarian value orientations toward the natural world, meaning that which of the orientations plays a role is dependent on the situation. For certain issues, Pluralists are likely to respond in a manner similar to that of Utilitarians, whereas for other issues they may behave more like Mutualists.	“You know, I'm not a hunter. I value wildlife more for appreciating its beauty and its place. But, I also understand why we have hunting [and] all the management regulations and exactly how it can benefit wildlife in general as well.” “I have mixed feelings…I was shocked by the amount of rabbits in Colorado, and that kind of conflicts with my gardening desire.”
	Utilitarian		Believe that the natural world should be used and managed primarily for human benefit.	“My husband ended up killing the baby rattlesnake.”

			They are more likely to prioritize human well-being over the environment in their attitudes and behaviors. They are also more likely to participate in consumptive activities such as hunting or fishing and see wildlife as pests or a nuisance.	
		Consumptive or abusive activities (defined below)	Interacts with the environment within the context of a consumptive or abusive outdoor recreation activity (defined below)	"Fishing is probably the closest I come to interacting with that type of wildlife."
		Nuisance/Pests	Sees aspects of the natural world as a nuisance, irritation, or pest that they want to get rid of	"Moths are everywhere and I keep telling them 'Don't come into the apartment! You don't need to be in here!'"
	Distanced		Neither a mutualism or a utilitarian orientation. As their label suggests, they tend to be less interested in wildlife and wildlife-related issues. More likely to express fear or disgust related to interacting with the natural world.	"I don't have that pull to want to go and be out in the wild."
		Fear/Concern for safety	Concern related to interacting with the natural world because of the possibility of harm, such as through injury or contracting disease	"I'm always kind of little on edge when I'm by myself out there."
		Disgust	Expresses disdain for interactions with the natural world but does not want to harm or use it	"I hate bugs…it's still so difficult for me to let stonefly nymphs crawl on my hands."
		Lack of interest	Demonstrates a lack of interest in the natural world and would rather focus attention on other things	"I'm not very active with wildlife I'll say that much. It's just not something personally that I really got into."
Assigned Value for Environment	Ecosystem focus		Participant assigns value to the natural world through the lens of ecosystems or system-level processes, such as placing emphasis on more scientific concepts like biodiversity or ecosystem health	"If you can teach kids the importance of biodiversity, then hopefully they'll live in a way to help promote biodiversity." "I definitely view wildlife as essential...I see the benefits of an ecosystem having a variety"
	Human focus		Participant assigns value to the natural world through the lens of humans, such as providing ecosystem services to us	"I just don't think people think of like ecosystem services that we get from wildlife all the time." "Knowing about the wildlife where you live...and how we benefit from them as well"
Pedagogical Value Orientation	Disciplinary Mastery		Participant emphasizes wanting students to come away with fundamental knowledge, understanding, and skills. Discusses course content in the context of meeting state	"I think that you should make sure you're covering what needs to be covered." "Interpreting graphs is just a skill that they need to develop in middle school."

			standards. Really wants students to be prepared for the following year.	
	Learning Process		Mentions skills like critical thinking and problem solving. Wants students to be able to think for themselves and come to their own conclusions. Focuses on the process of learning rather than grades or other academic outputs.	"Giving them the tools to gather their own information and interpret the data and come to their own conclusions"
	Self-Actualization		Wants students to have real world skills. Recognizes students as people/humans and makes sure their voices are heard. Focuses on the "big picture" and nurturing students for more than just academia	"Making sure that they're hearing everyone's voices…Especially middle school students really, really need that support."
	Social Responsibility		Mentions civic engagement and social change. Relates course material to global issues. Wants to help students become "good people"	"I can't save the world and the animals on my own, so let's inspire younger generations to do that with me." "We expect respect"
	Ecological Integration		Experiential learning and other non-traditional practices, talks about sparking interest or passion. Local context. Caters course content to students	"I think students learn the most and are most engaged when you can incorporate their own interests."
Pedagogical Motivations			Why the participant pursued teaching as a career	"He just got kids excited about nature and science. And I wanted to be able to do something similar." "[I] realized I was missing the interaction with the kids so I went back and got my teaching license"
Pedagogical Behaviors	Place-Based Education		Teacher's presented definition of "place-based education"	"learning and knowing about where we live, but then applying it to the rest of the world" "utilizing the students and their understandings and their experiences, along with the resources that are around you"
	Implementation		Teacher's examples of lessons or activities in which they implemented PBE	"when we're doing a weather unit we Have students go outside of the classroom and sit and actually Look around" "there are a lot of geese around…I've shown like a video about geese and talking about like, why they're here in the middle of winter and, or anything that I can work it in"
	Importance/Benefits		Teacher's presented benefits and importance of implementing PBE	"I think students learn the most and are most engaged when you can incorporate their own interests"

				"I think it helps open their eyes to we have all that really cool stuff right here. They might just not have noticed it before."
Address Environmental Topics through NGSS	Disciplinary Core idea	Interdependent Relationships in Ecosystems	Teacher frames discussions of wildlife and the environment through a lens of system-level ecological connectivity and interdependence, key word being "ecosystem"	"even when we don't see the animals all around us like they're there and the trees and the grass and it's all connected" "It's like learning about ecology, food chains and food webs and like understanding each organisms role in the environment"
		Human Impacts on Earth Systems	Teacher frames discussions of wildlife and the environment around human interactions with and their impact on the environment	"I think bringing that into the human impacts on the environment is what are we taking out and how is that effecting our system" "It can help open up the eyes of students to like, realizing the real impact on environment every single day"
		Organization for Matter and Energy Flow in Organisms		"So I try and bring it in, in different ways. So we talked about, like biological mechanisms, like how geese maintain body temperature for homeostasis"
		Natural Selection / Adaptation		"We talked about it with genetics. And genetic diversity and talking about like, life history and life strategies for different animals. I'd like to bring in some examples of like, super inbred communities or different things. I do a lesson with evolution and classification. related."
	Practice	Analyzing and Interpreting Data	Teacher uses discussions of wildlife and the environment as an opportunity to focus on inquiry, defining problems, and what it means to be a scientist	"I like the data speaking for itself, rather than me just saying, Well, climate change is climate change" "Anyone from any background can be a scientist if they've got the passion for it"
		Asking Questions and Defining Problems	Teacher uses discussions of wildlife and the environment as an opportunity to have students analyze and interpret data, such as interpreting graphs	"We look at [an experiment] and say, 'What did we learn?' And then, 'What questions do we have now?' That's an approach that I use all the time."