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'Unthinkable' Selves: Identity boundary work in a summer field ecology enrichment program for diverse youth

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The historical under-representation of diverse youth in environmental science education is inextricably connected to access and identity-related issues. Many diverse youth with limited previous experience to the outdoors as a source for learning and/or leisure may consider environmental science as 'unthinkable'. This is an ethnographic study of 16 diverse high school youths' participation, none of who initially fashioned themselves as 'outdoorsy' or 'animal people', in a four-week summer enrichment program focused on herpetology (study of reptiles and amphibians). To function as 'good' participants, youth acted in ways that placed them well outside their comfort zones, which we labeled as identity boundary work. Results highlight the following cultural tools, norms, and practices that enabled youths' identity boundary work: (1) boundary objects (tools regularly used in the program that facilitated youths' engagement with animals and nature and helped them work through fear or discomfort); (2) time and space (responsive, to enable adaptation to new environments, organisms, and scientific field techniques); (3) social support and collective agency; and (4) scientific and anecdotal knowledge and skills. Findings suggest challenges to commonly held beliefs about equitable pedagogy, which assumes that scientific practices must be thinkable and/or relevant *before* youth engage meaningfully. Further, findings illustrate the ways that fear, in small doses and handled with empathy, may become a resource for youths' connections to animals, nature, and science.

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Finally, we propose that youths' situated identity boundary work in the program may have the potential to spark more sustained identity work, given additional experiences and support.

Keywords: *Equity; Identity; Environmental science education; Informal education; Field science; Herpetology*

Histories of participation in outdoor leisure and learning activities (Warren, Roberts, Breunig, & Alvarez, 2014), the environmental and field sciences (Taylor, 1996), and environmental activism (Allen, Daro, & Holland, 2007; Taylor, 1997) demonstrate gaps in participation between the wealthy and poor, urban and rural, and Caucasian families and families of color (Taylor, 2002). While we do not assume a monolithic perspective—that all youth from underprivileged and non-dominant groups have limited experiences or interests in the outdoors (Marouli, 2002)—many youths' experiences and interests in outdoor wild spaces may be limited due to a number of factors. First, youth living in urban areas or from lower socioeconomic backgrounds simply may not have access to green spaces and biodiversity (Cilliers & Siebert, 2011; Hope et al., 2006; Iverson & Cook, 2000; Pauleit & Golding, 2005; Tratalos, Fuller, Warren, Davies, & Gaston, 2007); their geography may perpetuate their alienation from and/or prompt fears about natural environments (Fisman, 2005). Second, family habitus, that is, families' values, everyday practices, and 'taken-for-granted notions of "who we are", and "what we do", and what is "usual" for "us"' (Archer et al., 2012, p. 885), may not include the outdoors and wildlife, thus rendering nature as an 'unthinkable' context for leisure and learning. Third, Holland and Lachicotte (2007) argue that notions of 'environmentalist' are historically raced and classed, perpetuating a vision of 'outdoorsy' people as White and economically privileged. Limited exposure may prompt fears about natural environments that perpetuate youths' alienation from wild flora and fauna (Bixler, Carlisle, Hammit, & Floyd, 1996; Dillon et al., 2006; Van Veslor & Nilon, 2006).

Diversifying environmental science education is also entangled with the following identity-related issues, which arise from the science education literature about equity: (1) diverse non-dominant youth typically do not see science or scientists as relevant to who they are or want to be (Archer et al., 2010; Brickhouse, Lowery, & Shultz, 2000); (2) science learning settings do not often leverage and may even actively marginalize the resources youth bring to the settings (Calabrese Barton et al., 2013; Tsurusaki et al., 2013); (3) school practices do not easily promote contexts for identity transformation because the likelihood of cultural reproduction is so great (Carlone, Scott, & Lowder, 2014; Wood, Erichson, & Anicha, 2013); (4) science 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 (Archer et al., 2012; Carlone, Johnson, & Eisenhart, 2014). 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

like improving public health and access to health care, combating environmental degradation and environmental racism, developing renewable energy, and ensuring safe and affordable food' (Carlone, Johnson, & Enfield, in preparation).

We argue that youths' alienation from *nature* is problematic because we care about youth recognizing the rich biodiversity in their own backyards and protecting ever-diminishing habitats. 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. People who live in socioeconomically depressed areas are often the most impacted and least protected by environmental and health hazards. Many families are spending more time indoors and are increasingly disconnected from nature (Louv, 2008), which prevents them from reaping the many social, psychological, and physical benefits from regular contact with nature (Kellert, 2005). Providing all youth opportunities to spend time outdoors, learn about and connect with native flora and fauna, is a social justice issue.

We kept these issues in mind as we embarked on a study of diverse high school youths' engagement in a four-week herpetology (the study of reptiles and amphibians) summer enrichment program. The program was designed to ignite an interest and passion for local reptiles and amphibians, develop a sense of place and connection to the local environment, and introduce youth to field ecology experiences to cultivate their understanding and appreciation of the environmental sciences. Fairly quickly into the study, we began to understand youths' participation in the herpetology program as intertwined with identity work and, in particular, with *identity boundary work* because of their perceptions of who they were (not 'outdoors' or 'animal' kinds of people) and who they were asked to become ('outdoors' and 'animal' people). This was especially pronounced because they were working with reptiles and amphibians, groups of animals that often elicit narratives of fear and disgust (Fanini & Fahd, 2009; Grant, Middendorf, Colgan, Ahmad, & Vogel, 2011; Iztok, 2011). In other words, youth were asked to act in ways that placed them well outside their comfort zones. We do not claim that this situated identity boundary work signaled long-term changes in youths' identities, but we acknowledge that these shorter term identity performances could potentially spark more enduring identity work, given support.

As the research progressed, we found that nearly all youth engaged in identity boundary work in some form. Thus, our interest became less about *individuals*' identity boundary work and more about what made that work possible. Our research question was: What cultural norms, practices, and tools promoted diverse high school youths' identity boundary work in a summer enrichment program focused on herpetology?

Conceptual Framework

Learning as Identity Work

This study is framed by the assumption that learning about nature and herpetology is not only about acquiring skills and knowledge. It is also about seeing the natural world in new ways, asking questions one did not think to ask before, and seeing oneself and

being recognized by others as competent (Carlone, Haun-Frank, & Webb, 2011). In this definition, learning is a process of identity development (Lave & Wenger, 1991). Others have argued that this situated view of learning is particularly well suited for studying non-dominant youth in informal environmental science education settings (Aguilar & Krasny, 2011; Dillon, 2003) because it highlights participants' meaning-making and the processes by which learners get positioned as peripheral or central in a learning community (Brickhouse, 2001).

Our study is based on an anthropological perspective on identity, focused on the ways *individuals*' competence, performance, and recognition of self is contingent upon, in part, group-level (*cultural*) norms and practices of a particular setting (Carlone, 2012). In other words, we cannot wholly answer the question of individuals' identities without simultaneously answering questions about the kinds of learners youth are obligated to be in a given setting. This way of studying identity, based on social practice theory (Holland, Lachicotte, Skinner, & Cain, 1998), means examining the 'culturally produced meanings of "science person" [in a setting] and the accessibility of those meanings' (Carlone et al., 2011, p. 460) for all participants in the setting. Carlone (2012) explains, in anthropological studies of identity:

> Rather than ask, 'Who's struggling?' shift the lens to ask, 'What does it mean to struggle [in this setting]? What is the struggle about? How is struggling defined?' Rather than ask, 'Who's successful?' ask, 'What does it mean to be successful? What opportunities does the setting provide for individuals to become successful? (p. 12)

Building on the current identity studies literature, we prefer to understand identity as a *process* of identifying (or not) versus as a reified achievement (Calabrese Barton et al., 2013; Jackson & Seiler, 2013; Johnson, Brown, Carlone, & Cuevas, 2011). Our focus on identity *work* reflects three theoretical assumptions about identity: (1) people are formed in practice, within communities of practice that have histories of participation; (2) people have agency in who they can become in a setting, but that agency is often limited by the norms and practices within the setting, and by larger social structures; (3) social identification occurs within multiple timescales (moment-to-moment; across weeks and months, and across generations) (Holland & Lave, 2001; Holland et al., 1998; Wenger, 1998; Wong, 2012; Wortham, 2006). Because our study occurred within a relatively short period of time, we focused on moments of authoring (performances of self in practice) within any given activity, patterned and shared across most or sometimes all members of the group, that indicated 'working through fear' or 'discomfort' or 'otherness'. In the everyday activities created in these spaces, youth not only acted out who they were, but also played roles that were consistent with who they thought they were and/or who they wanted to become (Brickhouse, Lowery, & Schultz, 2000).

Identity Boundary Work: Playing in spaces of 'unthinkable' selves

Youths' identity work involves defining who they *are not* as much as it involves defining who they *are* and want to be and in deciding what they will and will not do (Akkerman

& Bakker, 2011; Benson, 2003; Wenger, 1998). Even with overwhelming constraints of structures shaping daily interactions, practices, and meanings, youth exert some intentionality, making choices and creating meanings and narratives about themselves, marking some identities 'thinkable' and others 'unthinkable' (Archer et al., 2012). Doing herpetology constituted, at the very least, a type of 'action boundary' crossing—at the very edges of what the youth participants previously considered themselves doing. As Benson (2003, p. 64) argues, 'I am what I can and will do, but also, of neglected significance, what I cannot do and will resist doing', illustrating the tight connections between actions (behaviors), acts (meanings imposed on those behaviors), and identity work (Harré & Moghaddam, 2003). Benson (2003) describes 'unthinkability' as understanding why or how someone might do something they found highly aversive. Our research question, however, asks what practices prompt identity boundary work that, for us, is desirable; increasing youths' access to and interest in field science and herpetology, areas many of them did not previously consider 'thinkable'.

During adolescence, identity boundaries are fluid as youth work out who they are and want to be. Unthinkability is part of what guards these boundaries, but so do negative emotions, like fear, embarrassment, and disgust (Benson, 2003). Many youth in our study could not picture themselves doing herpetology (e.g. capturing, holding, and measuring a snake in the wild) 'without, at the same time, having inhibitory negative feelings' (Benson, 2003, p. 71). Furthermore, positive emotions of pride, ownership, and belonging guard boundaries, but also might make them more porous. The role of emotions in learning and identity work cannot be overstated. Geijsel and Meijers (2005) explain the ways 'boundary experiences'—experiences of learning or growth, often wrought with conflict, uncertainty, and emotion—play a central role in identity work.

When considering boundary-crossing endeavors, one chooses to be part of a *group* that has norms, practices, and values that may nudge one's *personal* action boundaries; one's desire to be a part of that group may override personal feelings of fear or disgust in performing oneself in 'unthinkable' ways (Benson, 2003). Fitting in and being a 'good' member of the herpetology enrichment program entailed all sorts of actions youth with less exposure to wild spaces and wildlife never imagined themselves doing; for example, filing marginal scutes (outer edges) of turtle shells to mark them for scientific study, and wading into a murky lake up to one's belly with chest waders to retrieve turtle traps that contained snapping turtles. These practices were initially scary and undesirable for many youth, but they came to perform and embrace them as something 'we' do.

Though the past two decades of educational research have brought increasing attention to the concept of 'boundaries', with a focus on the ways 'markers of difference are created, maintained, or contested' (Akkerman & Bakker, 2011, p. 135), we know of no other work that focuses on identity boundary work. Our ideas are informed and inspired by boundary studies in general (Akkerman & Bakker, 2011) and the work of Tzou and Bell (2012) in particular, though they do not use the term 'identity boundary work' per se. In their ethnographic study of high school

youths' meaning-making in an environmental justice program that included classroom instruction and community service work, Tzou and Bell (2012) illustrate how the program's activities and lectures inadvertently created borders between youth and the natural world. The service learning trips and classroom activities perpetuated a 'rhetoric of fear and privilege' that emphasized environmental hazards, dangers, and human-made toxins that positioned 'youth and their communities in disempowering ways' (p. 267). For example, the environmental educator perpetuated a rhetoric of fear by using scientific jargon when explaining a chemical's omnipresence in youths' homes in their personal care and beauty products and a discourse of privilege by assuming youth had means and access to buy chemical-free personal care products. Youth, not surprisingly, resisted these narratives. Tzou and Bell's (2012) study prompted us to closely examine the ways the herpetology program created and/or minimized boundaries between youth and the environment and the ways youth responded to the program's goals of connecting youth to local, common, and often overlooked and underappreciated wildlife. In the next section, we explain how our analysis gave rise to the construct of identity boundary work.

Methodology

Context

This paper reports on the first summer of The HERP Program, funded by the National Science Foundation (ISE# 1114558). All authors of the paper are part of The HERP Project team as researchers and/or instructors, are White women, and have extensive experience in teaching and/or studying environmental education, herpetology, and/or science education. Further, nearly all researchers have spent the bulk of their careers (15–45 years each) working with mostly under-represented groups in science, environmental education, herpetology, and/or field ecology. Even so, our positionality and experience with and knowledge about nature and science carry with it power and privilege, and therefore we had to be methodologically rigorous to minimize researcher bias (Maxwell, 2013). Participants in the summer 2011 Herpetology Research Experience (hereafter, herpetological research experience (HRE)) reported here were part of a local college access program based on academic enrichment, leadership development, and family involvement (Academy). The Academy (a pseudonym) serves academically promising high school students with significant financial need and/or no family history of college. The mission of the Academy is to support these youth who are underrepresented on university campuses as they pursue higher education, build leadership skills, and develop an active sense of social responsibility. The year-round program combines four-week summer residential experiences on campus prior to the sophomore, junior, and senior years as well as a monthly Saturday Academy during the academic year. During the month-long summer program, youth choose two courses from a variety of academic classes, including the HRE. Other class choices included: criminology, financial literacy, physics, protest music, the brain, and college access.

During the summer of 2011, 16 youth enrolled in the HRE; 9 females and 7 males. Six percent of the youth were Native American, 25% were Hispanic/Latino, 31% were Caucasian, and 38% were Black/African American. The HRE prompted many 'firsts' for the youth. On our exit survey of youths' prior science and nature experiences, most youth reported that they had never attended a special science program (86%), did not have science-related hobbies (86%), and had never held an amphibian or reptile (71%). Participants also indicated that they had limited experience with wild spaces. They did not often camp (71%), fish/hunt (86%), star gaze (86%), watch weather patterns (86%), study clouds (86%), take care of animals (71%), or visit lakes, ponds, and streams (71%). The HRE met four days per week for four weeks, two hours per day. The purpose of the course was to introduce youth to foundational knowledge of the natural history of local amphibians and reptiles and engage them in several ongoing scientific studies. Youth gained experience collecting, interpreting, and reporting scientific data. They were exposed to careers in the field sciences and met and worked with several herpetologists. The nature of the HRE was familial, collaborative, and caring. The program's instructor, Terry Tomasek, also an author on this paper, is a science teacher educator, formerly a middle and high school science teacher (for youth aged 12–18 years), and holds advanced post-secondary degrees in Biology and Science Education.

Data Collection and Analysis

At least two researchers (not including the course instructor) observed, took field notes, video- and audio-recorded every day of the HRE instruction. All names used in this study are pseudonyms to protect participants' confidentiality. Our data analysis methods were emergent, largely informed by Carlone's prior research on youths' identity work in science learning settings (Carlone, Haun-Frank, & Webb, 2011, 2012; Carlone et al., 2014).

Phase 1. Establishing patterned identity boundary work and its markers. We began data analysis with classic ethnographic questions: What is going on here? What does this experience mean to youth participants? (Spradley, 1980). Our field notes were filled with striking examples of youth working through fear, so that is where we began. This first phase of data analysis focused on research group examinations of video excerpts centered on youths' encounters with live animals in the classroom and in the field because that is where students experienced the most trepidation and discomfort. We noted that, time and again, youth were willing to work through their discomfort to engage fully in the activities. We became interested in how often this occurred, with what participants, and in what kinds of activities. For a lack of a better label for this back-and-forth, no-I-won't-do-it/yes-I-will-do-it authoring, we came up with the label 'identity boundary work' after reading Tzou and Bell's (2012) research on borders and diverse youths' positioning outside dominant narratives of fear promoted in environmental education. We came up with markers of identity boundary work, based on all the video excerpts and field notes we reviewed up to that point—

working through fear, working outside one's comfort zone, otherness ('That's not me'), and moving from hesitation or peripherality to willingness to engage fully in an activity. The construct of identity boundary work emerged from our examination of the nature of youths' engagement with animals and wild spaces.

Because our study occurred within a relatively short period of time, we focused on *moments* of authoring within any given activity, patterned and shared across most or sometimes all members of the group, that indicated 'working through fear' or 'discomfort' or 'otherness'. We looked for these moments of authoring through their social performances in practice—for example, during the classroom, fieldwork, informal, and interview spaces and found that all youth, in one or more spaces, engaged in identity boundary work of some kind. Nearly all youth engaged in identity boundary work in nearly every activity dealing with wild animals and wild spaces.

Phase 2. Establishing the norms, practices, and tools that encouraged identity boundary work. Once we established the pervasiveness of identity boundary work amongst all youth, we marked those instances in the video excerpts for further exploration. We re-visited characteristics of each identity boundary experience in the video excerpts, asking ourselves: What were youth doing? What prompted the fear or discomfort and how did they work through that? What resources (cultural norms, practices, and tools) were leveraged to minimize fear or discomfort? We looked for patterns amidst practices, norms, and tools until we established data saturation by ensuring that one or more of our themes could explain each instance of a youth's identity boundary work. Most of the authors on this paper did nearly all of this analysis collaboratively. It was extremely beneficial to have the course instructor (Tomasek) help us analyze these data because her 'insider' perspective provided us important insight regarding the explanatory power of the emerging themes. Two authors (Hegedus and Huffling) went back to ensure data saturation across video excerpts.

Phase 3. Evidence of identity boundary work in youths' interviews. At the end of the HRE, we conducted 45-minute interviews (audio-recorded and transcribed) with 15 of the 16 participants for whom we had child assent and consent from parents. The interview protocol was originally designed for broader purposes than studying identity boundary work per se—we created the protocol to determine youths' meanings of the HRE experience and their identity work within the HRE by eliciting their narratives of experience and their meanings of specific normative social and scientific practices that were a regular part of the HRE. For this study, we analyzed interview questions that explicitly asked youth to recount instances of working through fear, being brave, and/or doing something they never thought they would do. Further, we combed the transcripts for other places in the protocol where they expressed narratives of identity boundary work. Thus, the interviews, though designed for broader purposes, provided us with plenty of evidence for youths' identity boundary work and norms and practices that promoted it. We used NVivo 9© to code all instances of identity boundary work in the interviews, and then we sub-coded each excerpt if youth explicitly discussed norms,

practices, and tools that encouraged them to work through fear, to be brave, to work outside of their comfort zones, and/or to try new things (e.g. to engage in identity boundary work). The themes youth discussed aligned well with the themes we identified in the video analysis, which enhanced our finding's crystallization, resonance, rigor, and credibility (Srivastava & Hopwood, 2009; Tracy, 2010).

Results

'I'm Not an Animal Person': Establishing Identity Boundary Work Across Participants

On the first day of the HRE, Dr [Name blinded] began the class by eliciting each youth's reasons for choosing the HRE as one of their classes for the Academy (Audio-recording and Field notes, 21 June 2011). Only one of 15 participants relayed that he spent a lot of time exploring outdoors; he was a Boy Scout. Five of 15 participants explained that they took the class to 'get over fears' of reptiles and amphibians. One participant flatly said, 'I'm not an animal person'. When asked to share stories of their experiences with reptiles and amphibians in their small groups, youth shared 'worst-case scenarios'; their stories were wrought with themes of narrow escapes from 'gross' and 'scary' snakes or frogs, myths about frogs giving you warts, and fantastical tales of giant pythons. In other words, with the exception of one participant, most youth did not fashion themselves as nature enthusiasts, budding herpetologists, or field scientists.

We were interested in understanding how youth negotiated spaces that prompted discomfort, 'otherness', and even fear. Many of the youth *initially* distanced themselves from and described themselves in direct opposition to the identity performances promoted in the summer program. For example:

> Jameka and Calvin walk into the classroom the first day and spotted a snake in the aquarium. 'Oh, *no*!' Jameka pronounces.
> 'I'm not turning around,' Calvin quips, 'Do not even make me look at that snake.' (Field-notes, 21 June 2011)
> I came into the course like, 'I'm not gonna touch a frog, I'm not gonna touch a salamander, and snakes? No way! But I thought I really surprised myself by handling the amphibians and reptiles. (Kendra)
> I had to work through fear a lot. Probably every field trip we took was a big jump for me. It meant a lot, though, because if you kept going and [tried things], you'd feel happy about what you did. (Kyra)

Though many approached the learning opportunities with trepidation, they also did so with open-mindedness, bravery, intense curiosity, and willingness to author themselves in new ways. This tension— between distancing themselves and being willing to engage in ways that closed the distance—set up a rich context for a study of identity boundary work. What norms, practices, and tools enabled their identity boundary work? We identified four themes: (1) boundary objects; (2) time and space; (3) social support/collective agency; and (4) anecdotal and scientific knowledge and skills. In the next section, we provide an overview of each theme, along with data to

illustrate each theme's relevance for youths' identity boundary work. Because these cultural norms, practices, and tools did not work in isolation, we provide a vignette with interpretive commentary at the end of the results section to demonstrate how the themes worked in concert to support youths' identity boundary work. The vignette is a realistic vignette, representative of many of the youths' identity performances during field experiences (VanMaanen, 1988).

Boundary Objects

We considered boundary objects to include physical tools that facilitated youths' identity boundary work; that is, tools that enabled youth to move out of their self-professed comfort zones to engage in science or with nature in ways that surprised them. For example, we saw changes in youths' identity performances as they donned *waders* to walk out into the lake, pulled in and checked the *trap* for turtles and other organisms; changes in their affect toward animals as they peered into an *aquarium* to closely observe a snake, frog, or turtle; their growing willingness to see the frogs they heard during frog call hikes at night using *headlamps* and *flashlights*; and how they would shift from looking scared to smiling as they got closer to the animals to take pictures with *cameras* (italicized words are examples of boundary objects).

We labeled boundary objects as such if they: (1) were a central feature of some activity that facilitated changes in youths' engagement; and (2) were tools regularly used in the HRE designed to bring youth closer to and understand the animals or some aspect of nature; or (3) the youth explicitly named the objects as helping them work through fear or discomfort. Boundary objects minimized power differentials between youth because they afforded gradual movements toward increasing participation (Lave & Wenger, 1991). Table 1 provides a list of examples of boundary objects and affordances for youth participants.

Table 1. Examples of boundary objects and their affordances for students' identity boundary work

Boundary object	Affordance
Waders/rubber boots	Decreased fear of the water (lake, ephemeral pool, and stream) so that youth had more access to animals and scientific practices of mark and recapture studies
Headlamps/flashlights (at night)	Decreased fear of the night and unknown creatures; allowed youth to conduct frog call studies
Headlamps/flashlights (during day)	Extended vision by enhanced lighting and assisted youths' abilities to see more of animals' features for species identification
Traps/aquaria	Contained animals so students could get closer than they might dare if animals were 'loose' in the wild
Hand sanitizer	Allowed students worried about germs to wash their hands immediately after handling animals
Cameras	Helped students 'forget' about how close they were getting to organisms—instead, students focused on getting good photographs or video. Enhanced their vision to see more of animals' features

Many youth were initially afraid of the animals. When we asked Jorge whether or not 'working through fear' was a norm of the HRE, he replied:

> Yes. I had to work with frogs. And it was horrible. But I got through it . . . When we did the frog calling—there were so many frogs. You could hear them coming at you. It was dark. And I had a little flashlight. I was tryin' to look and jump if I saw one. I was ready to leave . . . I'm still scared of [them]. But if I see one, I'm not gonna run.

Jorge's narrative implies that the flashlight may have served as a boundary object, allowing him to continue with an activity that was quite scary for him.

We noticed, as others have reported (Randler, 2008), that the transition from learning about, observing, studying, and holding captive animals *in the classroom* before going into the field helped many youth get comfortable with herpetology. For example, the aquaria, with lids, helped the youth closely examine the animals without touching them and then gradually get brave enough to hold them.

> She'd (our instructor) tell us, 'Okay, don't lift the lid off this [right away] because this might jump at you.' I was like, 'Okay, I won't.' But I could still see it and observe it. (Yasmine)
> I guess grabbing the frogs [was an example of being brave] because they were really creepy because they move a lot. When she put them in the containers and we were getting them out, I was scared. But I grabbed them and just held onto them. We did it with my group. (Carmen)

As we catalogued the boundary objects, we noticed that they played varying roles in promoting identity boundary work. For instance, a few more hesitant youth mentioned note-taking with *clipboards* and *data sheets* as a role they liked to play because they were scared of the animals. Ramón said, 'Since I was scared of the frog, I would be the one that's writing the data. But my teammates actually measured it and saw what kind of frog it was'. While the clipboards and data sheets provided a safe way for Ramón to participate, they did not necessarily push him to engage in robust scientific practices or to observe the animals closely and carefully. They enabled him to stay in a peripheral role in his group during the frog activity, while his teammates did the work to identify the frogs. However, his role as scribe may have provided the necessary time and space he needed to more fully engage later (our second theme in this results section).

Time and Space

The four-week program provided time for youth to transition through stages of comfort as they explored herpetology, a field of science new to them. The more time and space they were given to get used to the animals, the less fear they had, and the more willing they were to engage in the program's experiences. Providing youth with deliberate, gradual allotments of time and space to familiarize them with the animals positioned them as agents of their learning—to claim voice to decide when they were ready to engage more deeply with the animals. The approach was responsive, not standardized, and not on a teacher-determined timeline. It also allowed peers who were more comfortable to model desired behavior for others.

Youth articulated the value of this responsive approach. Kellan, expressing the gradual nature of becoming comfortable with handling live animals, stated, 'Well, at the beginning, trying to touch the different things was hard, but when she showed us how to hold them and we wouldn't make them fall or make them scared, then it was easy'. Youth who entered the program with trepidation also articulated the importance of trust and safety.

> The project that I felt really good about myself was when we went outside and then collected the frogs. I grabbed a lot of frogs, and we collected data from the frogs. There was one frog that was sitting in the water and some of the people was like, 'We can't get that frog.' And I was like, 'Well, I'll try to get it.' And so I went and I grabbed it and we collected the data from it. (Kellan)

Yasmine also reflected on the gradual nature of overcoming her fears:

> At first, it was scary being near animals. But then, after a while, you get used to it. And now, I'm like—when I was out in the woods, I was just like, 'Ooh, let me see it. Put it in my hand' . . . I guess it's like they were—they gave me my space. So, I can go and do it when I felt ready. I guess they didn't pressure me to do it, but I mean, they did, 'Oh, you should try it.' Like gave me—how do you say it? Like, they tried to help me, I guess, and it really did help me, and I'm not that scared any more.

The instructor and peers provided her time and space, without external pressure, so that she could transfer a newfound level of confidence from the classroom to the field, so much so that she served as a student teaching assistant the following summer. Jada added:

> I feel like she (the instructor) tries to help you a little bit at a time to feel settled. She explains to you how you hold the animal, how you're gentle with it, the respect you should give to it—just some of the main things you should know, even if you are afraid, of how you could or would in the future hold animals.

In analyzing her own movement along the trajectory from scared, uncomfortable novice to braver, more comfortable full participant, Jada said, 'I guess I could say I was more the scribe and observer. I didn't really hold the animals a lot at first. I got out of my comfort zone a little bit as the class went on'.

Clearly, acclimating youth to new practices requires time and space that must be carefully matched to youths' needs to maintain their interest and willingness to be receptive to author themselves in previously unthinkable ways. This notion runs counter to a standard course of study and pacing guide that is normative for school science practices.

Social Support and Collective Agency

Sharing ideas, nurturing, and helping others were primary aspects of the HRE. Participants noted social support as enabling them to do things they would not have otherwise done (e.g. hold a snake; process an aquatic turtle; go 'off trail' to look for box turtles) and facilitating more meaningful field science data collection (e.g. they could not adequately process aquatic turtles for data collection unless they worked

together to do so). We view the norms of peer support and nurturing to be forms of collective agency (Kirshner, 2009). Youth draw on appropriate material and symbolic resources (ideologies, practices, and tools) to create and enact identity performances that are new and unexpected for them. Furthermore, 'people learn in ways that relate to their interests and expectations of other social actors in their lives, in ways which they are accountable' (Bell, Tzou, Bricker, & Baines, 2012, p. 274).

While the youth may not have initially affiliated with the animals, they certainly affiliated with one another. 'People's current feelings about themselves are … deeply influenced by the ways in which what they now most care about synchronizes with what those, among whom they live, most care about'(Benson, 2003, p. 81). This affiliation with one another served as a resource for their identity boundary work. For example:

> A lot of us took the course because we were afraid of animals, and we kind of wanted to get over that sacredness. So that brought us together. (Kaitlin)
> Kaya, when she actually touched a frog and she was amazed she could even do it. And she was proud of herself, and we were proud of her. Same with Jorge. (Randall)
> Well, some people do have fear of animals, so therefore, we just either tried to help them get through that fear or, if they can't handle it, just be as accommodating as possible. (Ramón)

Youths' treks through the woods also illustrate the power of social support. They moved from shrieking about walking through spider webs to, as a group, singing joyfully in the woods in a single file line. The social support led them to examine the animals more closely, enabling them to understand and 'know' the animals in ways that were previously inaccessible. When they got brave enough to hold the animals, they could see and understand more about them:

> You can see the definitions, jaggedness of the scales, the stripes, that you can't really see in photographs. (Raquel)
> A lot of times you have to do something you've never done before in order to learn more. (Kaitlin)

Youth felt safe to push their boundaries because their peers supported them; empathy was a shared norm of the group. As we know from the previous literature, cultivating safety and belonging are important aspects of effective youth programs (Eccles & Gootman, 2002; Kirshner, 2009).

Knowledge

Youth needed basic information to keep them safe, assure the safety of the organisms, and help them learn to identify the animals. The youth said:

> [The instructor] wanted us to get all this stuff we were learning [in the classroom], like how to tell the difference between the herps, so that when we got out on the field, we would know and we wouldn't just be going out there blind. (Kaitlin)
> You had to pay attention so you wouldn't hurt the animals and you wouldn't hurt yourself in the process. (Alyssa)

The more they knew, the less they feared and more willing they were to explore and engage. Three forms of knowledge emerged as important: (1) skills for handling animals; (2) scientific knowledge about the animals; and (3) anecdotal knowledge or 'tales from the field'.

Practical strategies for handling the animals enabled youth to hold an animal securely, without harming the animal or themselves. Once the instructor gave youth *explicit instructions about how to hold the animals*, they began doing so with more and more confidence. Many credited this newfound skill in helping them work through their fears. Kellan said:

> I never thought I was going to hold a salamander or a frog. So that was a first for me. It was a surprise because I've never held one of those before and I never knew what they felt like. I was always like, 'No, don't touch that'.

When asked what about the course enabled him to hold animals he replied:

> I guess learning about them and learning that all animals with a mouth will bite, so just don't get around their mouth. And learn how to hold them. For instance, a frog—you wouldn't want to hold his stomach because you can squish it. So you hold it by the two back legs and it holds him still. He can't even move ... So there's nothing that he can do. And a turtle, you hold it at the back of the shell between the two legs. It might scratch you a little bit, but it's not anything major. Just as long as it don't bite you.

The instructor provided a lot of practical knowledge about how to hold animals and use field science tools. Youth learned how to: safely check cover boards for snakes, retrieve aquatic turtle traps, untie the aquatic turtle trap when they caught snapping turtles, use field guides, walk in waders, and dress in the field to minimize threats of snake and tick bites.

During lectures and class discussions, the instructor provided youth with *scientific knowledge* about the animals that sometimes contradicted cultural narratives from youths' families. This required careful negotiation. However, youth seemed open to learning about and using their emerging scientific knowledge.

> I think what really helped me was when I found out that frogs don't give you warts. I always, always, always thought frogs gave you warts. And I guess you don't know until you actually look it up or have somebody tell you. So I think that it helped me a lot. It helped me open up to the course. It made me feel really good to be able to hold an animal and actually do it on my own and know what I'm holding and know some of the background of the animal. (Jada)
>
> [We had to] be open to do new things, and to challenge what you've always been taught about things. Like we learned about frogs that they don't cause warts. Everyone said they did. If we were all afraid to touch frogs because of warts, we would have never learned anything about them. (Kaitlin)

The third form of knowledge that enabled identity boundary work was *tales from the field*. Dr T. (full name blinded for review) often presented anecdotal, personal stories about her own field experiences. For example:

> Last August, I was walking out of my office building early one morning. When I opened the back door, I found a pair of gray tree frogs in amplexus laying eggs in a puddle on the

> sidewalk. I froze in my tracks, taking that brief moment to notice how much smaller the male frog was from the female frog. I wondered at their choice of egg laying sites recognizing that before the end of the day the puddle would be dried up and the eggs would have no chance for survival. I went to find everyone who was in the building at that early hour to come and see this spectacular event. Once the frogs hopped away, I gathered the eggs and put them in an aquarium in my office to see if I could raise them through the tadpole stage to froglets. (Name blinded)

Storytelling is common among practicing field scientists. Bowen and Roth (2007) described these tales from the field as anecdotes or 'elaborate tales of personal experience' (p. 182) that field scientists have that do not fit into the structure of scientific writings. These are not necessarily discussions of knowledge claims (such as would be in a journal article); they are more like 'bouncing ideas off each other' or sharing local knowledge. Bowen and Roth (2007) use the term 'heroic stories' to describe these narratives, which contribute to the social construction of the community of ecologists. 'Field ecologists constitute their community and establish who is a member in that community through sharing common experiences and interconnecting stories about diverse field observations that complement each other' (p. 182).

By sharing tales from the field, the instructor invited youth to begin to develop their own tales, which in turn had youth developing a community much like a community of field ecologists. We found it interesting that youth began sharing their own tales from the field on bus rides back to the University after fieldwork. For instance, during the aquatic turtle data collection, Raquel and her partner found a large snapping turtle in the trap they retrieved from the lake. During the episode, we noted her understandable trepidation and fear. However, on the bus ride home, she recounted the experience with confidence and even a bit of swagger.

Our discussion above describes each theme individually. Next, we illustrate how the themes worked in concert to support youths' identity boundary work. We do so with a realistic vignette (VanMaanen, 1988), crafted from field notes and video during an aquatic turtle field study experience (6/27/11), along with interspersed interpretive analyses.

Vignette as Illustration of Supports for Youths' Identity Boundary Work

> It was a hot summer day. A group huddles around Dr. T. (blinded for review). Youth swat gnats and fan themselves uncomfortably as they listen to Dr. T. describe how they will remove aquatic turtle traps from the lake. 'I don't want to go in', says one student quietly. 'We're going to get wet!' worries another. Amidst youths' whispers and murmurs, Dr. T. repeats the procedures. She asks for two volunteers to remove the first trap, and two girls tentatively step forward. As they don their waders, they struggle to keep their balance and have to rely on the help of others to get their footing. Cameras are poised and ready to capture this first time experience, and the girls smile and pose, showing off their waders as if they are newly acquired fashion accessories. Their peers call out, 'You look so cute!' 'You are stylin'!'

Interpretation. Youth are in an uncomfortable environment, but they are together. No one is immune from the gnats and heat, minimizing differences between the

herpetologist and youth, and between the youth themselves (social support and collective agency to get through the discomfort). They are dressed appropriately for fieldwork, adorned in waders (boundary objects). The instructor asks for volunteers, providing time for those who are less comfortable to try this new experience after they see their peers experience it (space and time). Everyone encourages the first volunteers so that they can be successful as they tackle new tasks (social support). They also assist the volunteers with getting into their waders and assure the volunteers that they look 'good' in the bulky waders (social support).

> As the girls enter the water, their peers tell them, 'Be careful' and 'Go slow.' Others ask, 'How do the waders feel?' 'Are you wet?' 'Does it feel weird?' They respond, 'This is cool! They feel neat. They are, like, suctioned to my legs! I'm not wet. It's a little hard to move because your feet get stuck in the mud. I've got it now.' We begin to hear comments from those on shore, such as: 'Raquel, we need to go in together' and 'No, I call next!' and Kalvin says, 'No, me and Jada go next.' Dr. T. replies calmly, 'Everyone will get a chance.' As they approach the trap, Dr. T. instructs the girls to grab each side of it so that turtles cannot escape. As they lift the trap out of the water, Alyssa exclaims, 'I think we got a snapping turtle because I can see its spikes.' They both abruptly let go of the trap, and it drops back in the water. Dr. T. calmly explains that if they keep the trap away from them, the turtle can't hurt them. She encourages them to carefully bring the trap to shore.

Interpretation. Participants on shore provide social support by suggesting, 'Be careful'. Participants in the water assure their peers on shore that the experience is safe, pleasant, and interesting. The volunteers in the water are wearing waders (boundary objects), and they are knowledgeable of aquatic turtles. There is a snapping turtle in the aquatic turtle trap, and they can and will bite (scientific knowledge about the animals). Dr T. assures the youth that they will be safe if they hold the trap properly (skills for handling the animals). The conversation by the watchers on shore has shifted drastically. Seeing their peers in the water, successfully retrieving the aquatic turtle trap means that they are ready to try it too (social support; time and space).

> As their peers rush to help the girls out of the water, Dr. T. opens the trap, explaining the process in detail. One youth asks, 'Is it really a snapping turtle?' There are murmurs of apprehension, such as, 'I'm not getting in the lake with those things!' Dr. T. simply replies 'Yep, it's a little baby one.' Dr. T. wrestles with the trap for several long seconds, trying to free the snapping turtle without getting bitten. The youth have formed a tentative circle around her. As soon as the snapping turtle is unveiled and Dr. T. scoops it up, the youth take a collective step backward. 'It's ugly; Man, that thing is mean looking; He's trying to bite you; He's mean; He look nasty; That is angry; He's mad; That thing is evil'.
>
> Dr. T. explains that the snapping turtle is not mean; rather, it is simply trying to protect itself. 'Imagine if something big just grabbed you and had you dangling in mid-air. Wouldn't you try to fight to get away?' The youth agree that they would and ease forward. Dr. T. continues to explain why the snapping turtle needs this defense. She asks the students about the differences between snapping turtles and box turtles they had studied previously. A student responds, 'A box turtle can close up.' Dr. T. explains that since the snapping turtle can't close up, it protects itself by biting. The more Dr. T. explains about the snapping turtle, the more the youths' comments change. 'He's kind of cute.'; 'I like his spikes'; 'He reminds me of the Pokemon®'; 'He's so

cute'; 'He's just upset about being held.' The youth move in even closer to see the snapping turtle's features that Dr. T. points out.

Interpretation. The more Dr. T. points out features of the snapping turtle, the smaller the diameter of the circle of youth becomes; the more they knew, the less they feared, and the more completely they engaged (knowledge). She draws on youths' knowledge from previous classroom and fieldwork experiences with box turtles to make connections with the snapping turtle's defense mechanisms. Throughout the vignette, youths' physical and symbolic boundary work is apparent, moving from fear to enthusiasm ('Let me try it next!') back to fear (snapping turtle), and then back to being willing to engage again. The process of identity boundary work is not linear, nor is it final; it is iterative and ongoing.

Discussion

Our study's focus on learning as identity work and the cultural supports that encourage it is in keeping with recent calls in the environmental science education literature to move beyond solely examining participants' attitudes, skills, and knowledge (Agyeman, 2003; Rickinson, 2001; Zandvliet et al., 2009). We argue that it was more than just knowledge and skills that supported youths' identity boundary work. The HRE, which was a completely new way of experiencing science for most youth, prompted them to perform in ways that surprised themselves. While we do not want to make claims that this four-week program prompted radical transformations in youths' long-term sense of self or that their meanings of the animals, the environment, or science matched our own, their performances in practice are illustrative of situated identity work, which others have argued can potentially lead to more enduring social identification (Bell et al., 2012; Hidi & Renninger, 2006). For example, Zimmerman (2012) described how Penelope, a girl interested in animals, began taking care of hamsters at home, leading to her studies of animal behavior, accessing media resources to learn more about behavior and taxonomy, and experimenting with the animals' diets and cages. She also began volunteering at a local pet store. These activities deepened her participation and interests, providing increased recognition from her peers as an 'expert hobbyist', which also sustained her interest in learning more about hamsters.

Youths' situational interests (Hidi & Renninger, 2006) may not have been stabilized after four weeks, but for at least some youth, this experience initiated 'extended pathways of deepening participation' (Bell et al., 2012, p. 273) and 'scopes of possibility for learning and identification' (p. 275). For instance, Yasmine signed up to be a student research assistant for the HRE the following summer, and all youth who were eligible to do so participated in one or more voluntary follow-up HREs during the next school year.

We also understand other limits of this analysis. For instance, all performances have an audience, and perhaps some of the 'fearful' performances we observed were dramatic performances meant to impress peers, instructors, or educational researchers.

Yet, our data were *replete* with fearful and uncertain identity performances, (whether made more dramatic for external audiences or not), across all participants in all of the activities involving live animals or the outdoors. These identity performances toggled among and between fear, bravery, pride, and confidence. Further, despite our (the authors') extensive professional experiences working with youth of color in many different environmental education, science, and field science learning settings, our enthusiasm for, and experience in, field sciences may have limited our analysis. To minimize this validity threat (*researcher bias*, in Maxwell's 2013 terms), our study design included long-term involvement, multiple sources of data, searching for discrepant evidence, and long discussions among the research team to ensure that these themes *resonated* with prior and subsequent work with high school youth engaging with herpetology (see Tracy, 2010, for an excellent discussion of resonance as an indicator of validity in qualitative research).

Insights About Engaging Diverse and/or Fearful Learners in Environmental Science

Despite some of the study's limitations, we maintain that the HRE provided youth a productive learning space, brought about by the material resource of boundary objects and the cultural norms of social support, time, space, and knowledge. The potential of this space raises provocative questions for engaging diverse youth in environmental science education. First, we wonder about the role of fear in environmental science education. Previous studies demonstrate the ways environmental education's narratives of fear *inhibit* youths' connections to nature (Tzou & Bell, 2012). We were intrigued by the ways that fear, in small doses and handled with empathy and care, became a *resource* for youths' identity boundary work and connections to animals, nature, and science. In another study about the cultural meaning of 'smartness' promoted in the HRE (Carlone et al., submitted for review) in Year 2 of the multi-year project (n=70 youth), we found that many youth equated 'being brave' with being a good, smart participant. Their descriptions of smartness in school science included no analogous descriptors. That 'being brave' might be at least partially constitutive of 'being scientific' is an under-examined phenomenon in science education. School science certainly does not give youth opportunities to be brave. Even literature about equitable science pedagogy, to our knowledge, does not discuss the ways allowing youth to work through uncertainty and situations that invoke some fear or bravery, may prove productive for learning in science. At the same time, we recognize the bravery required of under-represented groups in science for persistence in science-related careers (Johnson et al., 2011). Thus, experiencing learning situations where youth can safely work through fearful situations when they are younger may serve as an intriguing resource for later learning.

The second insight we had about engaging diverse and/or fearful learners in environmental science was a challenge to some taken-for-granted assumptions about equitable science instruction. Most recommendations for equitable instruction in the science education literature stem from one form or another of *cultural difference theory* (Carlone et al., 2014), which maintains that students from non-dominant

cultural groups often struggle in school science because they experience school's and/or science's norms, worldviews, and beliefs as a new cultural milieu (Aikenhead & Jegede, 1999). Implied solutions to achieving a more equitable science when drawing (implicitly or explicitly) on cultural difference explanations, include: identifying ways to make science more relevant to students' lives (Seiler, 2001; Xu, Coats, & Davidson, 2012), substantiating and building on the legitimacy of students' cultural ways of knowing (Cobern & Aikenhead, 1998), identifying students' funds of knowledge as a starting point to instruction (Moll, Amanti, Neff, & Gonzalez, 1992; Upadhyay, 2009), making science instruction more culturally relevant (Parsons, Travis, & Simpson, 2005), and facilitating instructionally congruent instruction (Lee & Fradd, 1988), where teachers are able to relate science instruction to students' linguistic and cultural backgrounds and experiences (Buxton, Salinas, Mahotiere, Lee, & Secada, 2013). The cultural difference theory approaches 'assume, *a priori*, that cultural worlds of students, science, and/or school science need bridging' (Carlone et al., 2014, p. 658), frame students' and school science's cultural worlds as binaries (Quigley, 2011), and/or treat the concept of culture as static and tidily bound (Seiler, 2013).

This was not a study of culturally relevant instruction per se. However, the findings, that students engage in a science they once deemed 'unthinkable' or 'unlikely' with joyful engagement and enthusiasm given adequate supports, bring to the fore questions that challenge taken-for-granted assumptions about what makes for an equitable science. In particular, do we underestimate youths' futures and imaginations when we limit what they should learn to that which is relevant to their immediate lives? Must scientific practices always be thinkable *before* youth engage meaningfully? Our findings suggest that encouraging youth to participate in new communities of practice, engaging in identity work previously unfamiliar to or unusual for them, challenges these premises commonly implied by much of the literature about how to make science more accessible and equitable for all youth.

While we agree that culturally relevant pedagogy can and should include activities that are immediately relevant for youth, we also argue that 'unthinkable' spaces might also be productive for developing youths' science-related interests and engaging in science identity work. Jada explained:

> [The HRE] helped me to find out who I was, that new things help me find out who I am and what I can do—and not just limit myself to the things that I normally do on a daily basis, or routinely.

Youth from less privileged backgrounds often have resources of resilience and persistence that help them confront and thrive in new situations (Lee, Spencer, & Harpalani, 2003; Yosso, 2005). At the same time, they may have less exposure to wide ranges of possible futures than their more privileged peers. While we argue that the cultural norms, practices, and tools leveraged to support youths' identity boundary work in the HRE were *responsive* to youths' needs, we worry that an overemphasis on *relevance* may discourage engaging youth in science in ways that they might initially deem 'unthinkable'.

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