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"So That We Can Save the Earth from Dying": Highlights from a Middle School Environmental Field Day

*Kenton Sena[1], Jill Abney[2], Hannah Ruehl[2], and Chris Barton[3]

[1]*Lewis Honors College, University of Kentucky, Lexington, KY*
[2]*Center for the Enhancement of Learning and Teaching, University of Kentucky, Lexington, KY*
[3]*Department of Forestry and Natural Resources, University of Kentucky, Lexington, KY*
**Corresponding Author*

Abstract: Continued urbanization is likely to reduce human-nature experience, transforming human-dwelt spaces into increasingly artificial environments and removing humans from interaction with non-human living things and their ecosystems. In urban spaces, outdoor experiential educational activities can help students increase their familiarity with the outdoors and get their hands dirty. This case study reports on an environmental field day for middle school students from an urban Kentucky middle school. Students rotated through three activities (picking insects out of leaf packs, testing water quality, and planting trees), then completed a brief survey designed and administered by their faculty. Students rated the tree planting activity more highly than the other two activities ($p < 0.0001$), suggesting that this activity was more accessible, interesting, and engaging to a broader range of students. However, student qualitative responses to the water quality and leaf pack activities demonstrated an ability to make connections between those activities and the broader world, such as the importance of their stream-water quality for the Gulf of Mexico, or the implications of finding pollution-tolerant insects for understanding stream health. Overall, we recommend planning field days with multiple activities that offer various entry points for students with a range of prior experience of nature. We also emphasize the potential for these sorts of activities to help students develop a sense of awe or wonder in nature—seeing and handling things they never considered before but now experience as profound and interesting. These observations are consistent with the literature demonstrating the need for human-nature experience (especially in urban areas) to support developing a sense of affectivity for the environment and interest in taking environmentally beneficial actions, as well as the role of place-based experiential education in helping students bridge that gap.

Keywords: *place-based education, ecology, environmental education, urban forestry, urban streams*

Globally, many people find themselves living seemingly separate from nature as the human population is increasingly concentrated in cities. In fact, nearly 70% of the world's population is expected to live in urban areas by 2050 (Eurostat 2016). This ongoing human migration from rural to urban spaces is associated with human disconnection with nature, termed the "extinction of experience" (Soga and Gaston 2016). As nature scholars, we know that this distinction is arbitrary—humans are a part of nature. However, our built environment can separate us from experiences with the natural world. And yet, human experience of nature is critical for mental health and well-being (Bratman et al. 2015; Hunter et al. 2019), and is associated with increased affectivity for nature and environmental action (Zaradic et al. 2009; DeVille et al. 2021). Conversely, disconnection from nature may lead to a lack of interest in nature, or, more problematic, a distaste for nature's less convenient or (to some) less aesthetic realities, such as bugs. In addition, these feelings of disconnection from nature also limit our ability to recognize the impact of human behavior on the environment.

Soga and Gaston (2016) describe decreased opportunity to interact with nature as a key cause

Research Implications

- Middle school students were invited to participate in an environmental field day.
- Activities included tree planting, picking insects from leaf packs, and testing water quality.
- Students tended to prefer the tree planting activity, but demonstrated higher levels of learning from the other activities.

for the decline in human-nature experience, a factor closely associated with urbanization. Urban dwellers have less opportunity to interact with nature because they are less able to access quality greenspace, both due to loss of greenspace to urban development (Dallimer et al. 2011; Zhou and Wang 2011) and degradation of remnant greenspace (Foo 2016) through fragmentation (Li et al. 2019), species invasions (Johnson et al. 2020; Santana Marques et al. 2020), pollution (Peters 2009; Liu et al. 2022), and biodiversity loss (Turner et al. 2004). This lack of access is exacerbated by social and economic inequalities—members of under-resourced communities and minoritized racial and ethnic groups often have less access to high quality greenspace (Wen et al. 2013; Dawes et al. 2018; Spotswood et al. 2021). Extended to an environmental education context, urban students, and especially those from under-resourced and minoritized communities, may have negative assumptions about or predispositions toward nature due to a lack of previous positive experience of nature—that is, they might immediately assume that stream-dwelling insects are gross without giving them a chance to be cool.

Because of the critical importance of nature experience for human wellness and the many barriers restricting access to greenspace for urban dwellers, especially for members of under-resourced communities, increasing opportunities for positive interaction with greenspace in urban areas and increasing the quality of that greenspace, are essential. Urban forest restoration can improve air quality (Kroeger et al. 2014), sequester carbon (Teo et al. 2021), increase biodiversity (Simmons et al. 2016), mitigate the urban heat island effect (Kroeger et al. 2018), and manage stormwater (Pataki et al. 2021). Moreover, engaging in urban restoration activities can enhance affectivity for nature—a key leverage point for reversing the loss of human-nature experience (Whitburn et al. 2018). For students with a negative attitude toward nature, caring for their own community greenspaces, through activities such as planting trees and assessing water quality, may help them overcome those preliminary misgivings and develop a more positive affectivity. The tree they plant, which may grow throughout their lifetime, is worth them getting a little muddy.

Place-based, experiential environmental education programs in K-12 classes are uniquely positioned to engage urban students in caring for their local community greenspaces, both enhancing greenspace quality and improving student attitudes toward nature. Students participating in experiential learning programs outdoors generally report positive attitudes toward their experiences (James and Williams 2017), emphasizing their appreciation of out-of-classroom learning (Genc et al. 2018). These programs also support increased environmental knowledge (Hoover 2020), more developed environmental attitudes (Genc et al. 2018; Hecht and Nelson 2021), and changed environmental behaviors (Hoover 2020). Importantly, place-based environmental education can be especially impactful for students from under-resourced schools (Stevenson et al. 2014; Stern et al. 2022), although with exceptions (Wyner and Doherty 2021). Furthermore, as James and Williams (2017) note, experiential learning can be more accessible and impactful for students with learning differences or difficulties, emphasizing the importance of place-based outdoor learning in ecology and the environment for inclusive education. However, implementing experiential learning programs in K-12 curriculum can prove difficult if educators lack confidence in aligning place-based programming with standards (Merritt and Bowers 2020; Wright et al. 2021). Overall, local stewardship activities, such as water quality assessment and tree planting, may be good entry points for educators hoping to integrate place-based opportunities in their curriculum. In addition, introducing students to noticing and caring about their local greenspace may help students discover an appreciation for the outdoors that transcends the curricular experience, resulting in changed attitudes toward and voluntary engagement with nature. Students who initially dismissed stream-dwelling insects as gross may be more willing to get in the creek and flip rocks the next time they visit their local park.

This case study reports on a field day engaging 167 eighth grade students in water quality sampling, stream health assessment, and tree planting activities at a local urban forest and stream site. These eighth graders attend a middle school in the second largest city in Kentucky. The majority of this middle school's student population are listed as both minority students (68%) and as economically disadvantaged (69%) (USNWR 2021). According to a 2013 study examining the 85-square mile urban service area, a tree canopy covers at least 13,000 acres (25%) of that space (Davey Resource Group 2015). Student participants completed a post-trip survey to reflect on their experiences, including rating their preferred activity (tree planting, water quality, and leaf pack) and sharing something they learned from each activity. We reviewed survey results to address the following research questions: 1) Did students prefer one activity over others? and 2) Did student self-reported learning vary across these activities?

Methods

A team of middle school educators, local government employees, and faculty from the local state university hosted this field day at a community forest within a local park. This forest was planted as part of a community tree-planting event in 2000 and has since developed a closed canopy and vertical forest structure (overstory trees, understory shrubs and trees, and a shade-tolerant understory herb layer). Additionally, the forest is experiencing significant pressure from invasive plants such as Amur honeysuckle (Sena et al. 2021). The field day consisted of three stations (tree planting, water quality, and leaf pack stations) which students rotated through in three different groups throughout the course of the day. At the tree planting station, led by the local government urban forestry division and a local non-profit organization whose mission is to restore forests, students used dibble bars to plant native trees in an area of the forest where invasive species had recently been cleared. Station leaders emphasized the importance of trees for ecological health and human well-being. At the water quality station, led by faculty and students from a local university, students analyzed stream-water samples for turbidity, pH, nitrate, phosphate, and dissolved oxygen. Station leaders emphasized stream connectivity—that upstream processes influence downstream water quality, eventually leading to the Gulf of Mexico—as well as sources of water pollution and the influence of underlying geology on surface water quality. At the leaf pack station, led by faculty and students from a local university, students picked through leaf packs that had been incubating in the stream for several weeks, finding and identifying individual insects using forceps, hand lenses, and field guides. Station leaders emphasized that some insects are sensitive to pollution and will not survive in a polluted stream, while other insects are more tolerant to pollution. Students spent 15 – 20 minutes at each station, then ate lunch in the field before returning to school.

After the event, faculty at the partnering school developed and administered a survey to evaluate student attitudes toward the activities, as well as what they learned during the event. Survey responses were shared with the project team with all identifiers removed; a preliminary Institutional Review Board (IRB) review designated this project as Not Human Research (NHR). Survey questions are summarized in Table 1. Questions 1-3 asked students to rate their attitudes toward each activity (tree planting, water quality, and leaf pack) on a scale of 1 – 5, with 1 being the worst and 5 being the best. Question 4 asked students to rank the activities from their most favorite to their least favorite. Finally, questions 5-7 invited students to share something they learned from each activity, and question 8 asked students to reflect on why scientists were interested in studying stream health at this site. We note that the survey was developed and administrated by the middle school to collect routine feedback on the field trip; it was not developed from the outset as a research instrument. In some cases, in hindsight, some questions could have been rephrased to more rigorously assess the research questions, or survey design could

Table 1. Survey items list for student post-activity reflection.

Survey Question	Options
Rate how you felt about the tree planting activity.	1 – 5, with 1 being worst and 5 being best
Rate how you felt about the water quality activity.	1 – 5, with 1 being worst and 5 being best
Rate how you felt about the insect activity.	1 – 5, with 1 being worst and 5 being best
Which activity did you like the best, second best, or least?	Ranked activities 1 – 3, with 1 as favorite and 3 as least favorite
What did you learn while planting trees?	Free response
What did you learn at the water quality station?	Free response
What did you learn from the leaf packets?	Free response
Please explain why scientists are interested in the health of the stream at Masterson Station.	Free response

have been adjusted to improve data quality (e.g., students were able to rank multiple activities as their "favorite"). Furthermore, given the large number of students who responded "I don't know" or "I don't remember" to the qualitative questions, adding a brief description or picture of each activity to help students remember the activity in question may have helped to jog their memory. With these limitations in mind, we believe the survey results give insight into developing and implementing a field day for middle school students, supporting future efforts to engage students with diverse backgrounds and varying levels of prior nature experience in learning and living in the natural world.

Quantitative data (feelings toward each activity; activities ranking) were analyzed using a Kruskal-Wallis test, with follow-up pairwise comparisons using a Wilcoxon test with a BH adjustment (Benjamini and Hochberg 1995). Qualitative data (responses from the free response questions listed in Table 1) were coded independently by two members of the project team and discrepancies reconciled. The codebook for this process was developed with attention to students' tendencies to offer responses demonstrating varying levels of thinking and different experiences of content proficiency. We designed our coding scheme to loosely mirror Bloom's Taxonomy, a hierarchical classification of learning outcomes commonly used in K-12 lesson design (Table 2) to consider which activity, if any, lent itself to higher levels of cognition.

Results

To examine students' attitudes toward the activities individually, students were asked to rate each activity on a scale from 1 – 5 (with 1 being the worst and 5 being the best). Student reactions to the tree planting activity tended to cluster in the 4 – 5 range, with a few outliers in the 2 – 3 range (Figure 1). With the water testing and leaf pack activities, student responses tended to be more spread out, with the denser areas of reactions clustering around option 3. This preference for the tree planting activity was significant ($p < 0.0001$), with students rating the tree planting activity higher (4.25) than both water quality (3.31) and leaf pack (3.15) activities (Table 3).

Consistent with student ratings of each activity individually, student ranking of activities from favorite (1) to least favorite (3) demonstrated a preference for the tree planting activity (Figure 2;

Table 2. Codebook for student open-ended responses.

Code	Definition	Examples	General Correlation with Bloom's Taxonomy
Recalls basic properties	Student lists something descriptive or identifiable about the trees, water system, bugs, etc.	"Snails can live in the leaves." "The biodiversity in the river." "How much acidity there is."	Remember (Recall facts and basic concepts)
Identifies step(s) in a process	Student mentions a step or steps in the processes shown that day like how to plant a tree or how to evaluate water quality.	"You have to dig a big hole."	Understanding (Explain ideas or concepts)
Makes connections to larger, local natural ecosystems	Student articulates awareness of the connection between multiple natural and manmade details.	"The stream can easily be polluted from the sections from the stream that are in high populated areas." "I learned that the water quality is decided by a lot of things and because we live in Kentucky we have limestone that also affects the river."	Applying (Use information to make connections)
Articulates causal impact of humans (& vice versa)	Student makes conclusions about humans' causal impacts on the environment or the environment's impact on humans.	"That its easy to do something small that can make a big difference in the future."	Analyzing (Draw their own conclusions)
Evaluates quality or reality	Student makes an evaluative statement about the cleanliness of the water, whether it is drinkable, the number of trees, etc.	"It has a D rating."	Evaluating (Argues a perspective)
Establishes global conclusions	Student indicates some awareness of broader/global interconnectivity either through discussing places/ environments not necessarily addressed in the stations or through the creation of plans for improving the environment.	"It can flow to the Gulf of Mexico killing some fish." "Trees help the carbon dioxide in the atmosphere decrease."	Creating (Imagining or formulating additional applications and global connections)
Reflects on social connections formed in environmental work	Student makes reflective comments about the experience of the activities and the connections they made with other learners.	"Idk but I did have fun doing that. I felt adventurous." "Quite calming talking with friends while working."	Multiple (Evaluative, reflective, creative)
No appropriate code	Use this code if none of the others fit. Usually when no possible interpretation of the response is possible.	"Bugs"; "Yes"; "Water source"	NA
I don't know/NA	Student indicates lack of certainty about learning anything.	"I wasn't paying attention." "Don't know."	NA
Nothing	Student indicates they learned nothing.	"Nothing"; "Nothing it was horrible"	NA

Note: Students were asked "What did you learn while planting trees?"; "What did you learn at the water quality station?"; and "What did you learn from the leaf packets?". The chart also includes definitions, example responses, and each code's perceived connection to Bloom's Taxonomy of levels of thinking.

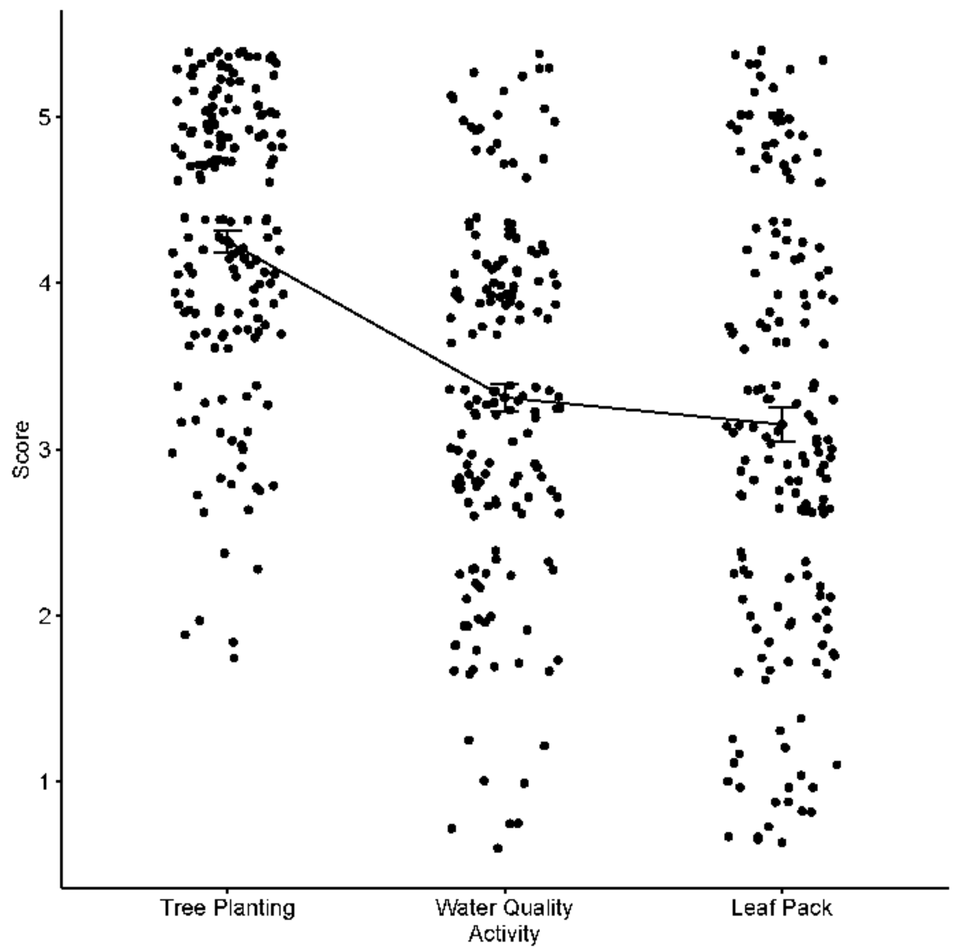

Figure 1. Student responses to "Rate how you felt about" each activity; students ranked each activity from 1 – 5 (with 1 being worst and 5 being best).

Table 3. Descriptive statistics for quantitative student survey responses.

Activity	Mean Score (± SD)*	Mean Rank (± SD)
Tree	4.25a ± 0.83	1.95 ± 0.91
Water Quality	3.31b ± 1.05	2.14 ± 0.66
Insect	3.15b ± 1.29	2.08 ± 0.77
Kruskal-Wallis chi-squared	87.2	3.50
Kruskal-Wallis p	< 0.0001	0.1738

*"Score" indicates student response to survey question "Rate how you felt about the activity." "Rank" indicates student response to "Which activity did you like the best, second best, or least?" "SD" = Standard Deviation. Means with different letters are significantly different ($p < 0.05$) across activities.

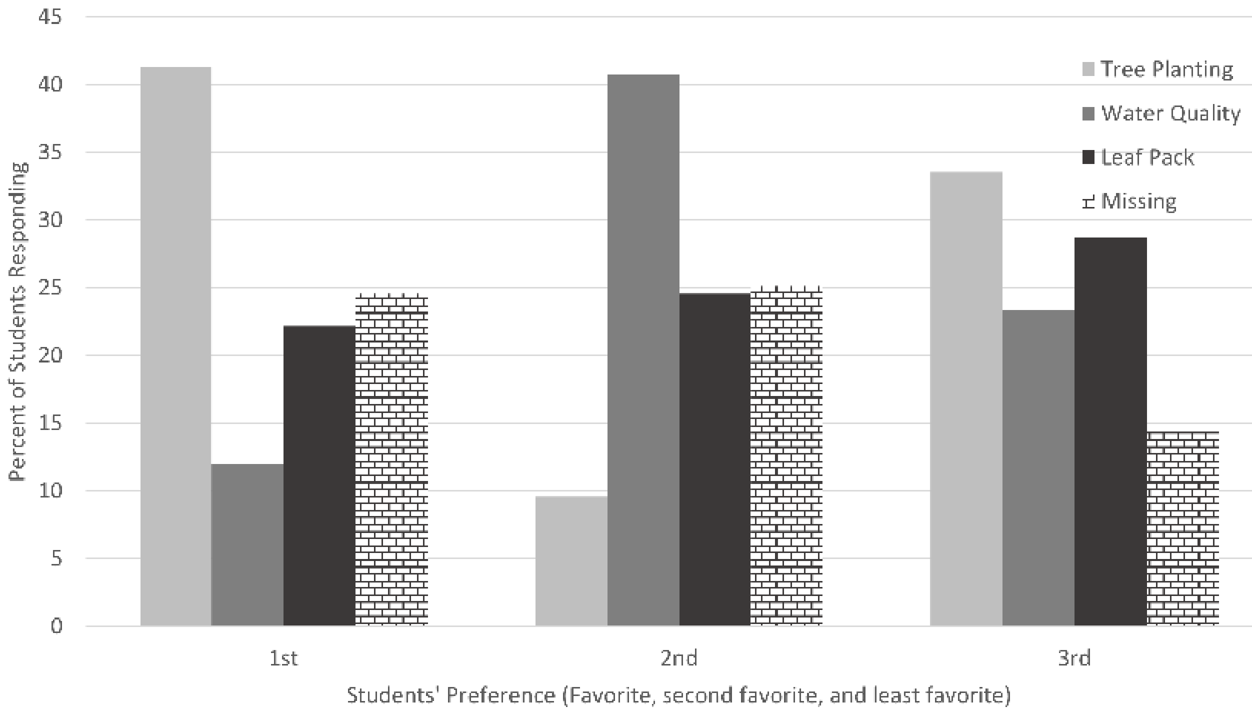

Figure 2. Student responses to "Which activity did you like best?" by percentage. Students were asked "Which activity did you like the best, second best, or least?" and were given the opportunity to choose 1 – 3 for each activity. The percentage of students with "NA" responses above either were missing that rank for any of the activities or had duplicates for that rank.

Table 3). When students were invited to rank which of the three activities they liked the best, 41.3% of students chose the tree planting activity, 22.2% of students indicated the leaf pack activity, and 11.9% of students chose the water testing activity. The most popular second place activity was the water testing activity (40.7%) followed by the leaf pack activity (24.6%). Interestingly, students tended to either rank the tree planting activity first or third, with only a small percentage (9.58%) ranking it second. We should note that the design of the question led to a lot of inconclusive data for this survey item because ranks were either duplicated or missing with 24.6% of responses for first, 25.2% of responses for second, and 14.4% of responses for third being uninterpretable. In some cases, for instance, students ranked all three activities as number one. These insufficient data indicate that the design of that survey item should be altered for clarity in future iterations of the survey.

Student qualitative responses demonstrated that field day activities supported a spectrum of learning experiences for students. For example, for the tree planting activity, many students shared that they learned how to plant trees ("I learned how to plant a tree") or about the significance of trees for human and environmental health ("Planting trees can change the environment and is important"). Other students remarked on some aspects of trees that they had not known before, such as the length or complexity of root systems ("Trees have very long and complicated roots at just a young age") and the names of trees ("I learned the names of trees..."). Students differed in their perspectives about whether planting trees was easy or hard ("It isn't that hard to plant trees" vs. "It was NOT as easy as I thought it would be"). When reflecting on the water quality activity, students shared about the significance of stream-water quality for human and environmental health ("We should know how clean or dirty our water is, because we literally drink out of it" and "They need good water quality for the animals"), and understood that humans are largely responsible for poor water quality ("The water is very dirty, mostly because of us and what we put in it"). They also recalled various aspects of the test methods demonstrated ("If the color looked darker the water could be bad but if it looked lighter the water is good") and noted the connectivity of our streams to both local and global earth and environmental systems ("The waters here are effected by limestone" and "The stream flows to different rivers in the us [sic] and then into the Mississippi River then to the Gulf of Mexico"). Finally, students reflecting on the leaf pack activity shared some degree of surprise at the number of insects in the stream ("There are lots of different bugs in the river...") and noted the importance of looking closely to find said insects ("Insects are small and aren't always big enough to see"). A number of students also commented about using insect community data to better understand stream health ("I learned that the insects on a leaf can help you determine the water quality"). In answer to the final qualitative question ("Why scientists are interested in the health of the stream..."), students noted human health ("It can get into the water that the homes use and they could end up drinking it or using it"), environmental health ("Because they want to make sure the stream is clean and not bad for the environment"), and their intersection ("Because we live in this part of the world and we love to see animals and bug [sic] that live in that stream"). Several students specifically noted that the study stream was connected to global environmental issues like climate change ("To help stop climate change by planting more trees so the trees can absorb the carbon dioxide that's in the atmosphere and the trees can give us the oxygen"), the Dead Zone in the Gulf of Mexico ("The algae blooms that happens in the Atlantic ocean it start in the streams and it could cause a big problem"), and global environmental health generally ("So that we can save the earth from dying").

When coding students' open-ended responses, the different activities inspired some notable differences in what students learned from the individual activities. Unsurprisingly, most of

Table 4. Number of student responses coded by level of thinking per activity.

Bloom's Connection	Code of Student Response*	Tree Planting Activity	Water Quality Activity	Leaf Packet Activity	Total by Code
Remembering	Recalls	33	54	64	112
Understanding	Identifies	66	32	11	109
Applying	Makes connections	11	11	8	30
Analyzing	Articulates impact	7	16	3	19
Evaluating	Evaluates quality	7	38	11	56
Creating	Establishes conclusions	2	4	2	8
Multiple	Reflects, imagines	1	0	0	1
NA	I don't know or nothing	4	9	22	35
NA	No appropriate code	2	5	5	12

*See full code text in Table 2. On occasion, responses were coded with multiple codes so the totals above do not equal the number of student participants (N=167).

the responses about what was learned from all three activities were identified as primarily remembering and understanding basic facts and steps (Table 4). But when we looked at these two categories of responses by activity, we noticed that students were more likely to demonstrate understanding of a process with the tree activity. Responses demonstrating an understanding of process occurred less often in reference to the water quality station and least often in reference to the leaf pack station.

Where the tree activity inspired more students to share experiences of understanding, especially as they related to the process of planting trees or the physical features of trees, students were more apt to demonstrate evidence of analysis and evaluation as a result of the water quality station. While the water station included an inherent quality of evaluation as a result of the testing process students used, it also often led students to cite connections to invasive species and the broader global connectivity of different water systems. Student responses indicate that they seemed to have the most trouble with the leaf pack activity. When asked about their learning related to that station, students were more likely to say "I don't know," "nothing," or "I don't remember."

Discussion

Overall, the results in all three activities highlighted how interaction with nature through varied opportunities can increase affectivity for nature (Zaradic et al. 2009; Whitburn et al. 2018; DeVille et al. 2021), environmental knowledge (Hoover 2020), and a recognition of the need for environmental action due to a growing understanding of the relationship between nature and humanity (Genc et al. 2018; Hecht and Nelson 2021). Specifically, student reactions to this middle school field day illuminate the potential benefits of a curated series of inquiry-based, hands-on activities targeting environmental education broadly and water education more specifically. The place-based, experiential activities highlighted in this study utilized tenets of inquiry-based pedagogies which, although lacking a centralized definition, generally employ a rethinking of the traditional educational model to create opportunities for students to ask questions, make connections, evaluate evidence, and solve problems (Brown 2017). These activities made space for students to engage in moments of environmental action by evaluating local water sources, getting their hands dirty, and asking questions about their local landscape. In their post-activity reactions, students indicated an awareness of local and global connectivity, environmental cause and effect, human/environmental interdependence, and – on a few occasions – nature's ability to help us connect with ourselves and others.

Most open-ended responses about what students learned during the tree planting activity recalled basic attributes of trees or the process of planting them. Nearly all these responses were also positive or neutral, absent of any abhorrence to digging or working in the dirt. Despite the commonality of trees and a growing urban tree canopy in our area, responses indicated that many students were notably lacking in knowledge about trees. For instance, one student articulated a new-found awareness about the structure of a seedling, stating that "The branch looking things are actually the roots and you have to plant that part of the tree." Similarly, students described the process of tree planting as "not that hard" and something that can be done "without seeds," revealing students' inexperience with how trees are cultivated. Someone with experience interacting with trees might assume the identification of the roots to be an unnecessary step, but for a student first encountering a tree as a seedling that observation is noteworthy and essential. The popularity of the tree activity in the rankings, combined with students' abilities to identify and understand steps in the tree planting process in their open-ended responses, suggest that the tree activity provided an accessible entry point for students, regardless of background and previous experience with nature. Regardless of whether students had limited experience with seedlings or planting trees before the experience, general awareness of trees provided a key foundation for their learning. The logical nature of the activity also likely increased student confidence in what they learned through that activity. The tactile process of identifying an appropriate place, digging the hole, identifying the roots, and burying them effectively required little global awareness beyond a likely source of water. On the other hand, the water quality and leaf pack activities required more complex steps of recognizing causation, unseen environmental factors, and global connectivity, which challenged student confidence in formulating conclusions and identifying what they learned. The results from the tree planting survey support the existing theories that experience with nature can increase the affective feelings toward nature (Whitburn et al. 2018; DeVille et al. 2021) and increase environmental knowledge (Hoover 2020).

The water quality activity elicited some unique responses from students, elucidating how interactions with nature can increase and develop their environmental knowledge even if their responses to the activity were not wholly positive. Many of them made sometimes contradictory notes about what they learned from testing the quality of the water, such as the water "is mad nasty" to "the water is pretty clean," suggesting that many did not fully understand what testing the water demonstrated or were off put by the appearance of the water. Still, many students understood that they were testing the water for different qualities: acidity, cleanliness, and desirable quality ("It turns green when you add the pill and you want it to be green"). Others indicated that they had a new understanding of the ecological and systematic role of water by noting human actions around water can affect the rest of the ecosystem like "I saw that we need to take care of the world because we have a lot of animals and bug that need that water." Others expressed ideas on how to protect the water through human actions, such as planting trees and being mindful of what we put in water ("That the water ph [pH] has decrease in the past 20 years by planting trees"). Importantly, others reflected on how the quality of the water affected humans ("We can't drink the water it will make us sick"). Through the range of responses, we can see how students understood some of the nuances of the water quality activity by reflecting on its broader impact on themselves and both the local and larger ecosystem and that this change could move them toward changed environmental behaviors (Hoover 2020).

Similar to the water activity, student responses about the leaf pack activity ranged from negative responses related to the perceived "grossness" of bugs to statements about learning to observe the world around them more intentionally as well as understanding the connections between aquatic insect communities and the water in which they live. For example, one student noted that "...if you take out the leave you can see microscopic bugs that you may not have seen before," and another said "They are A LOTTTT of insects, small, tiny tiny, or huge!!! It made me slow down and observe more efficiently." These responses highlight a response akin to wonder—students seeing something that they had not seen before and thinking it was cool. This wonder is especially clear in the student who commented "I saw a iceapod [isopod] and i though it was so sick and that it was a cool experience and it was fu[n] looking at it close up." Students learned that insects are everywhere—they just needed to know how and where to look. One student shared that "Leaves provide food and shelter for insects and other animals," demonstrating an understanding of habitat, and another noted that "...there are insects everywhere and most are not harmful." The emphasis here on insects as not harmful speaks to a cultural fear or dislike of insects, clearly communicated by another student, who said "Them bugs are nasty." Finally, several students shared about the connections between stream-water quality and aquatic insects, noting "That knowing what type of insects there are in a creek we can know how the water quality is," and "...if you find a bug that is prone to live in polluted places in the water you test then that water is most likely polluted." Not only do these responses evidence higher-level thinking—making connections between observed phenomena and their broader implications that support the use of place-based, experiential learning activities (Brown 2017), but they also demonstrate that creating these opportunities for students, even when they may find the activity 'gross,' has benefits for their learning.

Conclusions

During all these activities, students were asked to use scientific processes to evaluate the quality, impact, or habitability of their local forest and stream ecosystems. Scholarship about the use of inquiry-based teaching in science education suggests that these methods help improve students' knowledge of science concepts and their use of science practices (Marshall et al. 2017). The tendency for many students to comment on the process itself as they reflected on what they learned suggests that perhaps teaching middle school students about water as an alterable and changing resource, reliant on human behavior and awareness, can go a long way in empowering students to be more environmentally attuned. For some of these middle schoolers, it may have been the first time they were encouraged to scrutinize the natural world around them. The pairing of the activities also cultivated student awareness of the interconnected and often reciprocal relationships between different parts of an ecosystem, both locally and globally. Where students seemed to struggle to go beyond recall, understanding, and general observations were when those connections required following longer threads of dependency and more complex systems of interaction (i.e., the leaf pack activity). Perhaps future iterations of those activities that explore those more complex connections would be well served by building in some additional scaffolding and points of entry.

Student reactions to this field day indicate that projects seeking to help students recognize their connection to nature should go beyond simple observation. Rather, asking students to touch, dig, and impact their surroundings on a small scale helps bridge the disconnect many of us feel with the natural world. These activities prioritizing water education helped students recognize how nature can help them connect with themselves and others. Based on their responses, a few students found some level of introspection during the activities. When asked what they learned, they spoke about how the process made them feel. These introspective statements, although rare, hint at students' growing awareness of the impact working and playing out in nature had on them. For instance, one student indicated that as they planted their tree "It's quite calming talking with friends while working." One student said "I loved it! And you don't have to dig a very big hole." Another stated an awareness of the uniqueness of moment stating, "Idk [I don't know what I learned] but [I] did have fun doing that. I felt adventurous." Notably, this was the first field trip these students had taken in nearly three years due to restrictions during the COVID-19 pandemic, which may also have added to the feelings of adventure and awe students experienced. These comments call to mind studies that demonstrate the power of nature to inspire awe and wonder which can support personal well-being (Anderson et al. 2018). We did not code for statements of feeling, awe, or broadening individual awareness of their connection to the environment, but these instances suggest that time spent guiding middle school students in environmentally informed, intentional, collaborative activities present exciting opportunities for students to learn more about themselves in connection with the planet.

Our interpretations of the findings from this student survey are potentially limited by some constraints of our coding scheme and our inability to always glean the precise meaning of student responses. While Bloom's Taxonomy is a commonly used hierarchy of categories of thinking, there are those that rightly interrogate and complicate this model (Ritchart and Church 2020). While mental moves of identification or understanding can seem, at first glance, to be introductory level skills, a more accurate hierarchy of habits of mind would account for variable levels of thought at all stages of Bloom's hierarchy. We acknowledge those limitations of the framework and intend our use of the basic Bloom's divisions as a starting point and a tool for considering the accessibility of particular activities for certain students.

Additionally, coders were limited by the brevity of student comments that occasionally prevented clear interpretation of meaning. There were also comments that indicated awareness of global or local connections that might have been the result of students remembering something the activity facilitator said, rather than them independently making connections or analyzing variables. Lastly, it is impossible to know for sure each students' personal experience with the environment outside of these activities. The area these students live in is unique—the city is relatively urban but includes a notable urban tree canopy and is surrounded by a protected region of farmland preserved from commercial development through the local urban/county government's Agricultural Conservation Easement program. In addition, restrictions during the COVID-19 pandemic may have altered students' utilization of outdoor spaces for social connection, leisure, and activity. As a result, while many of these students may not have extensive experiences with their natural surroundings, there are certainly possibilities for those encounters nearby. Furthermore, student responses to the leaf pack activity may have been constrained by differences in wording—the questions for that activity called it the "insect activity" and "leaf packet activity"—the lack of consistent terminology may have made these questions more confusing for students.

Finally, we note that students' quantitative scoring and ranking of activities demonstrated a clear preference for the tree planting activity over the leaf pack and water quality activities. Paired with qualitative responses describing the water and insects as varying degrees of "gross," this underscores the reality that students, perhaps particularly urban students, come into natural spaces with various presuppositions, tolerances, aesthetics, and biases. In this case, running multiple stations ended up being an excellent strategy to address this reality—students who may not have appreciated the leaf pack activity as much may still have gone home with a generally positive attitude toward the field day as a whole because of the tree planting activity. Conversely, we note that student responses regarding the water quality and leaf pack activities tended to suggest higher levels of thinking, such as making ecological and global connections—while these activities may not have been the general favorite, they were certainly meaningful in an educational context. Our findings further support offering a constellation of activities for a field day, scaffolded to be accessible to students with varying degrees of prior knowledge, as well as a spectrum of biases and presuppositions about nature.

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Author Bios and Contact Information

Kenton Sena, Ph.D. (corresponding author), is a lecturer in the Lewis Honors College at the University of Kentucky, where he teaches the Honors Foundations Seminar and additional honors courses in ecology and the environment. He holds a B.A. in Biology from Asbury University, and an M.S. in Forestry and a Ph.D. in Integrated Plant and Soil Sciences from UK. His research engages urban restoration and imagined ecologies. He may be contacted at kenton.sena@uky.edu or by mail at 1120 University Drive, Lexington, KY 40526

Jill Abney, Ph.D., is a Senior Faculty Instructional Consultant at the University of Kentucky's Center for the Enhancement of Learning and Teaching. Her pedagogical interests include exploring strategies for building community and belonging in the college classroom. She holds a Ph.D. in history from UK and her research examines the role of gender, power, and rhetoric in 19th century Britain. She may be contacted at jill.abney@uky.edu.

Hannah Ruehl, Ph.D., is a Faculty Instructional Consultant at the University of Kentucky's Center for the Enhancement of Learning and Teaching. Her doctorate is 19th century British literature, and she is currently pursuing a Master's in environmental science. Her research focuses on the overlap of the science of curiosity and the science of learning in the college classroom and explores the psychology of habit in changing environmental behaviors. She may be contacted at hru223@uky.edu.

Christopher D. Barton, Ph.D., is a Professor of Forest Hydrology and Watershed Management in the Department of Forestry and Natural Resources at the University of Kentucky. He is currently working in the areas of ecosystem restoration and water resource management. He is also the founder and president of Green Forests Work, a non-profit organization whose mission is to restore forests on degraded land in Appalachia and beyond. He may be contacted at barton@uky.edu.

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