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Digging Deeper into Schoolyards and Data

An elementary ecology unit to lift up children's local knowledge

By Kathryn Lanouette and Sarah Van Wart

ABSTRACT

In the *Next Generation Science Standards*, there is sustained emphasis on working with data. Yet supporting elementary children's meaningful work with data, in ways that engage local places, people, and processes central to young peoples' daily lives, while also digging deeper into disciplinary core ideas, remains a challenge for teachers and curriculum designers alike. In this article, we outline how opportunities were created for children to construct and contest data as part of a larger multi-week ecology unit, in ways that both elevated children's local expertise and their intuitions about data. Key to this process was expanding the types of data children collected, centering the study of ecosystems around their schoolyard, and making maps as anchors for modeling and argumentation. We describe the core principles that informed this curricular approach, show how these principles were used to guide the design of a fourth- and fifth-grade curriculum, and reveal key insights children were able to gain about their schoolyard ecosystems. Connections to relevant science and math standards, along with select curricular materials, are provided.

KEYWORDS: 3–5; K–12 framework; *NGSS*; data modeling; ecosystems; analyzing and interpreting data

Data is central to science knowledge building practices, with analyzing and interpreting data being a core practice in the *Next Generation Science Standards* as well as in mathematics (*Common Core*) and statistics standards (*GAISE II* 2020). Children bring lots of intuitions and resources to making sense of data, strengthened by first-hand, direct opportunities to collect, construct, and contest data themselves (Hug and McNeill 2008). Yet opportunities for children to work with data in this way are less common, especially in elementary school contexts (Lanouette, Van Wart, and Parikh 2025). Instead, children are given preexisting data sets already cleaned and visualized, obscuring the original questions, tools, and decisions that produced the data. Additionally, this premade data is often about phenomena and places far removed from children's daily lives. This separation not only reduces the relevance of science learning but also overlooks children's multifaceted understandings of the local social, cultural, and ecological communities of which they are a part (Lim and Barton 2010).

Existing work has shown that creating and interpreting data using spatial formats such as map making and annotation can support young people interweaving their local expertise and questions into their reasoning about complex phenomena and processes in their neighborhoods and cities (Lanouette and Taylor 2022; Mitchell 1991; Mitchell and Elwood 2012). Yet elementary students rarely have the opportunity to collect and contest data about places they know well within common elementary science curriculum, particularly involving map making and map reading within broader science modeling investigations.

In this article, we share an approach for supporting fourth- and fifth-grade students (ages 10–12 years old) to create, analyze, and contest map-based data visualizations collaboratively, in ways that build upon both their expertise of local places and their intuitions about data. We describe a multi-week curriculum where late elementary students learned about ecosystem interrelationships by studying the soil ecosystems underfoot in their own schoolyard and using paper and interactive digital mapmaking as the basis for data modeling and argumentation (Lanouette, Van Wart, and Parikh 2025). Specifically, we show how children's existing local schoolyard knowledge—combined with cycles of creating and discussing spatial data visualizations—creates a powerful basis for learning about ecological systems and about data itself. Importantly, this approach supports more equitable learning within the classroom by changing who holds intellectual authority and who has access to the conversational floor in data-rich science discussions (from only the teacher and select students to everyone) (Engle, Langer-Osuna, and McKinney de Royston 2014). We first outline core principles that guided the curriculum development and then demonstrate how these principles were instantiated in a multi-phase curriculum interweaving *NGSS* disciplinary core ideas, cross cutting concepts, and scientific and engineering practices. See Table 1 for additional tips.

Core Principles Framework

Several core principles guided the curriculum design and sequencing. Combined, these principles show how map making in local places can support children's science learning about ecosystems and data, in ways that expand what counts as data and who counts as knowledgeable.

1. *Leveraging children's local insights*: Center studies of ecosystems within local places to leverage the multiplicity, heterogeneity, and depth of children's understandings about neighborhood phenomena, places, and processes (Davis 2025; Lim and Barton 2010; Schenkel, Brownell, and Wargo 2024).
2. *Building data expertise through cycles of data collection and analysis*: Build children's data expertise, involving them in the uncertainty of defining variables, determining sampling site locations, collecting data first-hand, and collaboratively building varied data representations across multiple cycles, to understand data "end-to-end" (Metz 2011; Manz et al. 2020).
3. *Exploring and discussing data in multiple formats*: Collect, visualize, and discuss multiple types of data—sketches, written notes, photographs, and numerical counts—to support analyzing and interpreting data in ways that elevate their intuitions of data and expertise about local places (Herrick, Lawson, and Matewos 2022; Lupi and Posavec 2016).

Curriculum Materials and Data Modeling Through Map Making

This multi-week curriculum is designed for late elementary students, within their regularly scheduled biweekly science class time (60–90 minutes). Students explore the driving question "Who can thrive here in the schoolyard?" as the basis for understanding interrelationships that constitute ecological systems in their immediate environs. Students are supported in exploring this question in three phases, starting with *leveraging children's local insights* into who and what might be underground from their daily experiences playing in the schoolyard, and selecting sampling sites to learn more, moving into *building data expertise* through their first-hand direct experiences defining variables and collecting data, and last *exploring and discussing data in multiple formats* to support collective analysis and interpretation. Below, each phase is described in detail, showing how the design principles translate into science teaching activities, varied data visualizations, and opportunities for data creation, interpretation, and argumentation practices.

Phase 1: Leveraging Children's Local Insights

The opening four lessons focus on "Who can thrive here in the schoolyard?" by centering the study of ecological systems in children's social and ecological immediate worlds.

As a class, children were asked to first brainstorm who and what might be underfoot in their schoolyard, with the teacher creating lists of the plants, animals, materials, and infrastructures they called out (Figure 1). As a whole class, children then used paper color maps of the schoolyard to think about where in the schoolyard it might be helpful to study in more depth to learn how these parts of the ecosystem might meet their needs, in particular schoolyard niches (Figure 2). Children were encouraged to bring forward what they knew from their daily experiences and routines in the schoolyard (Nespor 1997) in selecting initial sampling sites for further study and explaining their rationale for why that particular site might be useful to answering the broader driving question (Figure 3, see Supplemental Resources section for handout). Pairs were then selected to support socially cohesive working groups for the remaining two cycles of data collection and visualization, with each pair being responsible for selecting a schoolyard sampling site, collecting data there, bringing this data back to the whole class, and collaboratively building data visualizations together.

Throughout this process, children shared knowledge about interrelationships among the biotic and abiotic parts of the system, but importantly also considered how children and adults' movements above ground (e.g., morning pledge routines where children line up, games like tag and four-square being played) and changing daily sunlight and seasonal rainfall patterns might shape life underfoot. They were also asked to consider how built structures (e.g., buildings, asphalt, play equipment) might shape life underfoot at their sampling sites. This expansive understanding of the schoolyard—blending together ecological, social and built systems—is rarely supported in children's school-based science learning, especially in ecology studies. But it is essential for understanding how social and ecological systems function together, a key step in understanding complex socio-ecological systems (Learning in Places Collaborative 2020) and uplifting the important knowledge children have about their local community places.

Phase 2: Building Data Expertise Through Cycles of Data Collection and Analysis

Once children selected their sampling sites in pairs, they headed outside for two class sessions to collect a range of data about earthworms, other invertebrates, and plants' root structures, as well as soil characteristics such as moisture, compaction, and composition (Lessons 5–6). These indicators were identified by the students as being important to understanding "Who could thrive in the schoolyard?". This included (a) counting earthworms unearthed at their sample site, (b) setting pitfall traps, a passive sampling approach achieved by placing a cup in the ground with a light surface cover, to identify and quantify other invertebrates, (c) documenting the presence of root structures, (d) categorizing the soil related to moisture, color, and composition by observation and squeezing of soil samples, as well as timing water infiltration into pre-dug holes. These specific sampling methodologies were taught directly prior to data collection but built from prior third- and fourth-grade lab experiences related to soil and weathering (4-ESS2-1), map interpretation (4-ESS2-2), and ecosystem dynamics (3-LS4-3) DCIs.

FIGURE 1

Children's list of who and what might be underground in their schoolyard, sorted into living and non-living by the teacher to connect to grade level science standards.

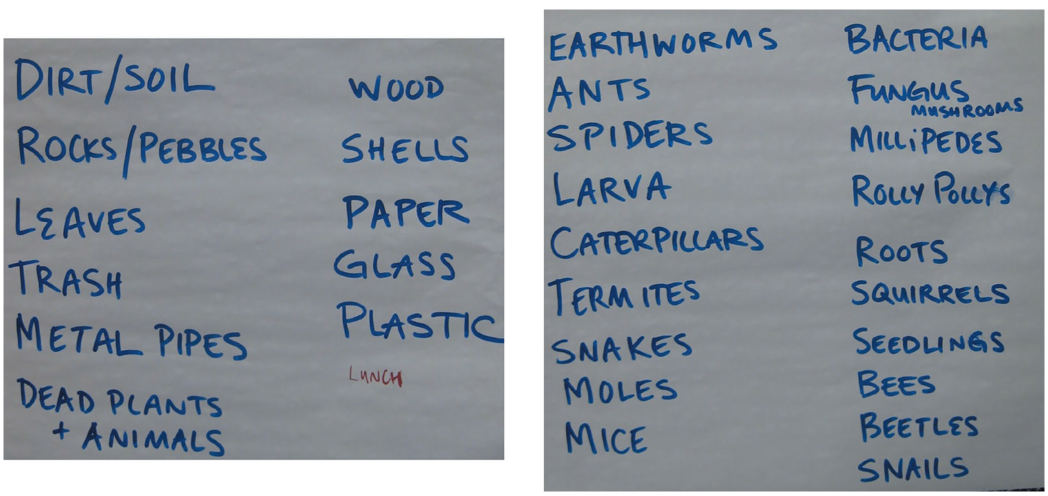


FIGURE 2

Children's schoolyard map with sticky notes showing their initial sampling site ideas.

Children also recorded human activities at their site with text notes, sketches, and photographs, describing routines and activities that children deemed important to schoolyard life underfoot (e.g., foot traffic, sound levels, other children's play activities). Safety precautions included wearing gloves and washing hands with soap and water after data collection. From these experiences, children developed a strong understanding of how the class's data was produced while also playing a key role in defining the focus of data collection efforts. In this first wave of data collection, the class collectively generated a wide range of data types (e.g., categorical, numerical, open-ended) about multiple parts of the schoolyard ecosystem, producing this data at 13 different schoolyard sampling sites that children selected themselves (see Supplemental Resources section for handouts).

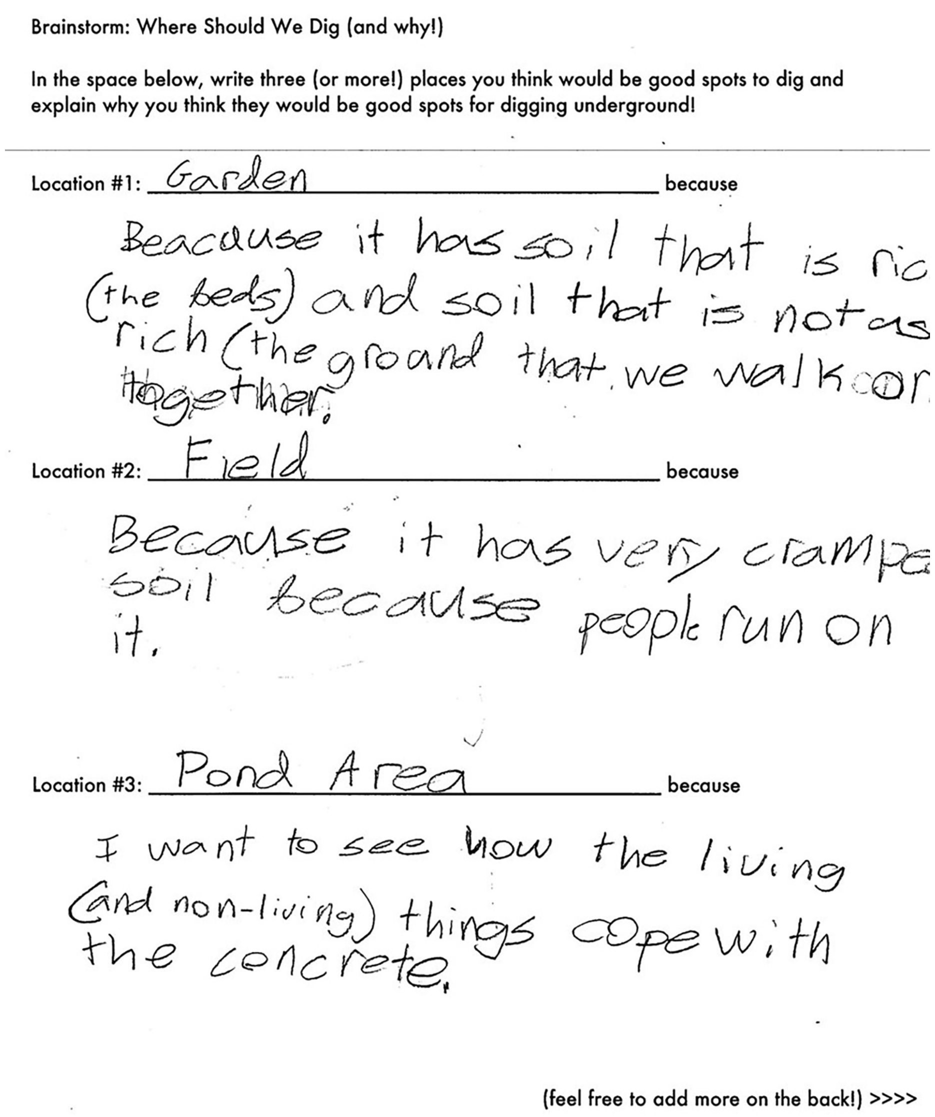
Children's data discussions using their digital data maps.

Phase 3: Exploring and Discussing Data in Multiple Formats

Over the next five class sessions (Lessons 7–12), children collaboratively constructed several data visualizations to

FIGURE 3

Examples of what children wrote on their sampling where + why note sheets.


Brainstorm: Where Should We Dig (and why!)

In the space below, write three (or more!) places you think would be good spots to dig and explain why you think they would be good spots for digging underground!

Location #1: Garden because

Beacause it has soil that is ric (the beds) and soil that is not as rich (the ground that we walk on) together.

Location #2: Field because

Because it has very crampe soil because people run on it.

Location #3: Pond Area because

I want to see how the living (and non-living) things cope with the concrete.

(feel free to add more on the back!) >>>>

explore relationships in the class's aggregated data, creating two paper data maps and an interactive digital data map, as well as a dot plot graph and two-way matrix. A digital data map is any software that allows users to visualize both quantitative data (e.g., geospatial measurements and observations) and qualitative data (e.g., notes, comments, drawings, photographs, audio, and video) based on location (i.e., latitudinal and longitudinal positioning in space), such as *Google My Maps*.

Initially, this entailed children building a paper data map of just earthworm counts at their sampling sites, using sticky notes and an aerial map of the schoolyard (Figure 4). Building this data visualization supported children noticing spatial distributions of earthworms, in relation to different niche environments within the schoolyard, and further considering what they needed to thrive. Next, children included additional variables, such as the presence of other invertebrates, soil moisture conditions, and the presences of root structures, using stickers. This map-based data visualization supported children to consider how additional dimensions of the schoolyard ecosystems might be influencing who could thrive where. In the next class, children built a two-way table of all invertebrate data, supporting identification of distinct species and exploring variation and distributions across the species (Figure 5).

FIGURE 4

Paper data map, with just earthworm counts on yellow Post-it notes.

Last, children uploaded and transcribed their site data—including their photographs, sketches, text notes, and numerical counts—using a web-based digital map platform called *Local Ground* (Van Wart, Lanouette, and Parikh 2020). Once converted to a digital form, students could explore both their own and their classmates' data using an interactive digital map (Figure 6), which allowed them to easily shift between data types (e.g., sketches, text, photos, counts) and spatial scales (e.g., zooming into a sampling site or viewing the entire schoolyard). Combined, these evolving data maps in paper and digital formats supported multiple opportunities to analyze and interpret data, drawing on children's local expertise of the schoolyard and developing expertise of the data itself to better understand the multiple parts of ecosystems and their interrelationships with one another.

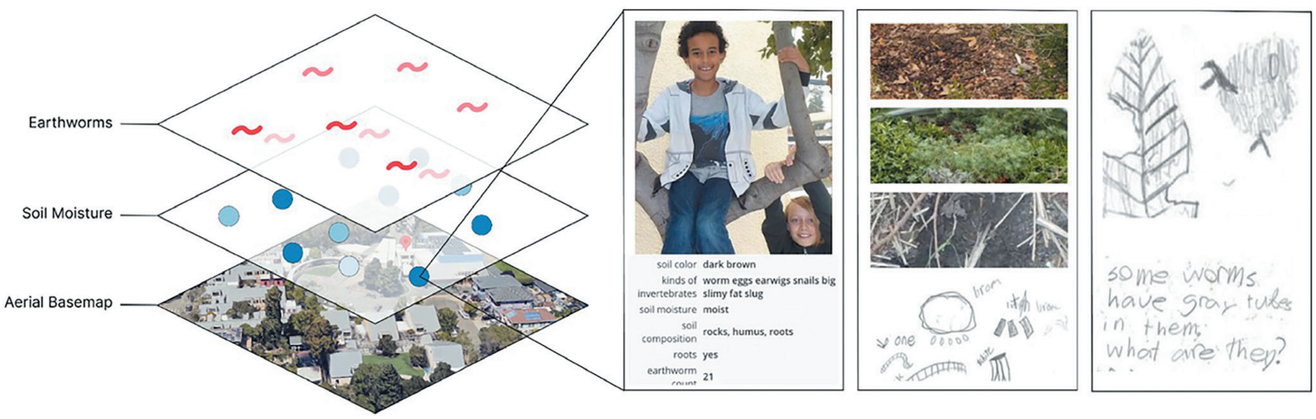
With each of these data map formats, children were supported in engaging in argumentation using evidence (Sandoval et al. 2023; Schrauben et al. 2021), where pairs of children took turns sharing conjectured relationships between biotic and abiotic parts of the system using their multiple data sources and formats. To prepare for these discussions, children first worked in pairs to analyze the data and record relationships they were noticing, seeking out "puzzles or patterns" they wanted to talk about (see Supplemental Resources for data discussion analysis sheets). With the help of written prompts, they also planned out what they wanted to say to their peers, noting the interrelationships, data sources, and opening conjectures they wanted to share (see Figure 7 and Supplemental Resources section for handout).

FIGURE 5

Other data visualizations, such as a two-way table of all invertebrates, support identifying species and exploring variation and distributions.

FIGURE 6

Interactive digital data map, showing children's categorical, numerical, and open-ended data.



Then, in whole-class discussions, pairs took turns using the paper and interactive digital data maps to explain patterns in the data and what insights they might draw from this data analysis to understand who was thriving in the schoolyard ecosystem. As they conjectured, corroborated, and contested claims about potential relationships, children drew on their expansive understandings of the schoolyard, interweaving their knowledge of sunlight and rainfall over the days, weeks,

FIGURE 7

Research meeting set-up.

3/23/17

L 16 Presentation Notes

Names: ____________________

Presentation Notes

#1) What big question do you want to explore and explain?

1. Soil infiltration + soil moisture and how they impact eachother
2. What are great/tough places for invertebrates?

#2) Tell us the specific relationships you are interested in exploring and explaining!

We want to explore and explain this specific relationship

Soil infiltration + Soil moisture + moist soil. Dry soil seems to have faster infilltration tim and very little worms.

#3) Tell us what data are most useful in showing this relationship (or break in the relationship)!

We are going to be using these two data sources (circle and describe at least two):

- data map
- photographs
- scientific sketches
- text notes
- bar charts

I believe sketches are also helpful when they include both a picture and notes

text notes are helpfull: because they explain more than bar charts, sketches and photographs.

#4) Tell us the reason(s) you think this relationship (or break in the relationship) is happening!

We think this relationship (or break in the relationship) in happening because Possibly because Mason and Kaleb's site possibly has a worse environment then the garden sites and that's why they didn't have as many worms. Dry soil can and seasons, alongside their knowledge of how the schoolyard was impacted by foot traffic and other human activities (gardening, building structures, daily routines). They also drew on multiple data sources in the process—including scientific sketches, text notes, and numerical counts—to support their claims with varied evidence. Importantly, this approach supports more equitable learning within the elementary classroom by changing who holds intellectual authority and who has access to the conversational floor (Engle, Langer-Osuna, and McKinney de Royston 2014), where knowledge is

TABLE 1

Thinking like data scientists: Data practices and facilitation tips for elementary science.

<table>
<tr><th>Data Science Practices (GAISE II)</th><th colspan="2">Facilitation tips</th></tr>
<tr><td>1. Formulate Investigative Questions
Devise a question that can be explored using local data.

Examples: “Who can thrive here in the schoolyard?” helped children consider local plants and animals and their needs.

“How can we find out?” helped children think about the tools, methods and data they needed to answer the question.</td><td colspan="2">• Create a data plan ahead of time. Consider the kinds of relationships you want to explore ahead of time, so you can guide children toward a feasible and generative data collection plan.
• Create a shared representation of the space to get children brainstorming – consider projecting an aerial map of the area on a whiteboard.
• Incorporate children’s knowledge and experiences – ask children what they already know about space, and note their ideas on the “whiteboard map.”</td></tr>
<tr><td rowspan="5">2. Collect/Consider the Data
Consider how collecting data can help uncover important relationships between the natural and built environment, using both qualitative and quantitative data.

Examples: Creating indicators to measure living things (animal counts) and their surroundings (soil, human activities, etc.) allowed children to analyze correlations between data and formulate socio-ecological theories such as:
• “Worms like moist soil.”
• “Decaying plants provide food for insects to eat.”
• “The soil is compact because kids play here a lot.”</td><td colspan="2">• Create worksheets with instructions around the specific measurements and observations that are needed, to streamline the data collection process.
• Allow children to choose their sampling sites (if possible), to foster ownership and accountability.
• Plan for multiple cycles – multiple rounds of data collection enables students to refine their process.
• Gather multiple data types – try to collect at least one indicator for each of the data types below:</td></tr>
<tr><td>Data Type</td><td>Examples of Indicators</td></tr>
<tr><td>Categorical
(multiple choice)</td><td>• Type of soil (moist, wet, dry)
• Sun exposure (shady, partial, full)</td></tr>
<tr><td>Numeric</td><td>• Number of invertebrates
• Temperature, weight, height, etc.</td></tr>
<tr><td>Open-ended
(qualitative, unstructured)</td><td>• Sketches of animals, plants and soil
• Field notes
• Site photographs</td></tr>
</table>

(CONTINUED)

TABLE 1. CONTINUED.

<table>
<tr><th colspan="2">Data Science Practices (GAISE II)</th><th>Facilitation tips</th></tr>
<tr><td colspan="2">3. Analyze the Data
Data analysis can take many forms, including finding outliers, examining distributions, noticing correlations or patterns in the data, finding surprising measurements, or discussing field experiences and activity patterns.

Examples:
• Building a dot plot of worm counts – to identify outliers and examine frequency distributions.
• Placing post-it notes of worm counts on a large paper map – to analyze their spatial distribution.
• Using digital maps – to discuss how different variables might be related (e.g., soil moisture and # of worms).</td><td>• Allow students multiple opportunities to explore and discuss their data – individually, in pairs, and in whole groups.
• Build analog and digital representations:
  • Paper-based methods (e.g., tallies, tables) tend to be more structured and collaborative.
  • With digital tools (e.g., Google My Maps or Google Sheets), students can independently investigate their own ideas.
• Center local knowledge. Children's notes, pictures, and memories from their fieldwork are also important sources of intuition and insight that can be utilized in their analysis.</td></tr>
<tr><td colspan="2">4. Interpret the Results (and Share Them)
Find ways to help children construct scientific explanations from multiple sources of data / evidence. Then discuss, contest, and debate these explanations as a community.

Examples of arguing from evidence:</td><td rowspan="6">• Moving from what to why: Support causal reasoning by asking children to answer scientific questions using evidence:
  • "Tell us about a relationship you would like to explain with your data."
  • "Why do you think this relationship is happening?"
• Small-group sensemaking: Allot time for pairs and small groups to interact with their data and prepare their conjectures and arguments for a whole-class discussion.
• Collective sensemaking: Allow children to present, discuss, and debate their conjectures with one another.
• Broadening forms of evidence: Encouraging children to draw not only on their measurements, photos, and notes, but also on their local knowledge and lived experiences, supports more inclusive and meaningful scientific sensemaking.</td></tr>
<tr><td>Claim / Counterclaim</td><td>Forms of Evidence</td></tr>
<tr><td>"Earthworms need moist soil, roots, and shade to thrive."</td><td>Measurements, field drawings</td></tr>
<tr><td>"But that site has no shade and lots of worms!"</td><td>Measurements, aerial map image</td></tr>
<tr><td>"Our site had the same circumstances as yours but we only found one earthworm."</td><td>Measurements, field experiences</td></tr>
<tr><td>"That soil is compact because kids play there."</td><td>Measurements, local knowledge</td></tr>
</table>

constructed collectively from literally the ground up and multiple ways of knowing the schoolyard (social, ecological, affective) are made visible and valued.

For example, many children made claims about what earthworms versus hard-shelled organisms like pill bugs and sowbugs needed to thrive and reciprocally, the way each of these organisms might change the soil moisture, composition, and color. These claims were supported with varied evidence, such as their scientific sketches to identify animal species, categorical soil moisture data, and numeric earthworm data. Several children also conjectured about the relationship between soil compaction, earthworm counts, and foot traffic, drawing together numeric data (e.g., time in seconds for water to be absorbed in the soil, earthworm counts), combined with gesture over the schoolyard maps to show common walking pathways. Additionally, children conjectured that different plant species observed above ground, like trees and bushes were surviving well due to variations in sunlight and rainfall, leveraging their categorical data about roots and soil characteristics with their photographs and text notes about their sites, as well as their local expertise of where sunlight moved and rainwater gathered. Combined, these discussions supported understanding how multiple parts interacted with one another, in ways shaping the larger schoolyard system.

In Lesson 13, student pairs then had the opportunity to select a second sampling site to further study relationships emerging in the class data, as well as to explore puzzling patterns, outliers, or anomalies in the aggregated data so far. This opened up the opportunity to test specific biotic/abiotic relationships that the class was identifying as well as to return to specific sampling sites to see what repeated sampling might reveal. Subsequent class lessons (Lessons 14–18) explored the two cycles of cumulative data using paper and interactive digital data maps. Students used their data science talk planning note sheets to plan out their opening conjectures and claims using the class data (Figures 5, 6, and 7). Across the multi-week curriculum, children often worked closely together in pairs, having autonomy in selecting sites of interest to study, gathering data together in these locales, and exploring trends and relationships in the data using collaboratively constructed analog and digital data visualizations to support sensemaking about their schoolyard soil ecosystems.

Conclusion

Given the primacy of data in both the *Next Generation Science Standards* and in scientists' knowledge building practices, it will be key for elementary educators and curricular designers to support science learning opportunities that engage young people deeply with the production, visualization, and critique of data. One approach detailed here is to leverage the broader expertise that children have about local places and data, expand what ways of knowing can be part of children's science learning, and expand what data can be part of their analysis and interpretation practices through a multi-week unit centered around children's schoolyard.

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ACKNOWLEDGMENTS

We are grateful to the children and educators who opened their classrooms and schoolyard to us, so that we could learn together how place, data, and mapping might be combined to create more expansive and equitable science learning. We thank the UC Berkeley undergraduate students who supported all aspects of data collection and technology iteration. We acknowledge partial funding support of this multi-year research project from a NAEd/Spencer Dissertation Fellowship to Kathryn Lanouette and a NSF grant no. 13198849 awarded to Tapan S. Parikh.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

RESOURCES

Google My Maps
www.google.com/maps/about/mymaps

STEM Teaching Tools: Qualities of Good Anchor Phenomena #28
https://stemteachingtools.org/assets/landscapes/STEM-Teaching-Tool-28-Qualities-of-Anchor-Phenomena.pdf

SUPPLEMENTAL RESOURCES

Supplemental materials for this article can be accessed online at https://doi.org/10.1080/00368148.2025.2586296.

REFERENCES

Davis, N. R. 2025. “Potholes and Sociopolitical Possibilities: Deepening Environmental Education for Black Children Living and Learning in the City.” *Urban Education*. https://doi.org/10.1177/00420859251359266.

Engle, R. A., J. M. Langer-Osuna, and M. McKinney de Royston. 2014. “Toward a Model of Influence in Persuasive Discussions: Negotiating Quality, Authority, Privilege, and Access Within a Student-Led Argument.” *Journal of the Learning Sciences* 23 (2): 245–268. https://doi.org/10.1080/10508406.2014.883979.

Herrick, I. R., M. A. Lawson, and A. M. Matewos. 2022. “*Through the Eyes of a Child:* Exploring and Engaging Elementary Students' Climate Conceptions through Photovoice.” *Educational and Developmental Psychologist* 39 (1): 100–115. https://doi.org/10.1080/20590776.2021.2004862.

Hug, B., and K. L. McNeill. 2008. “Use of First-Hand and Second-Hand Data in Science: Does Data Type Influence Classroom Conversations?” *International Journal of Science Education* 30 (13): 1725–1751. https://doi.org/10.1080/09500690701506945.

Lanouette, K., and K. H. Taylor. 2022. “Learning Within Socio-Political Landscapes: (Re)Imagining Children's Geographies.” *Occasional Paper Series* 48: 3–12. https://doi.org/10.58295/2375-3668.1471.

Lanouette, K., S. Van Wart, and TS. Parikh. 2025. “Participatory Digital Mapping, Dynamic Data, and Children's Science Argumentation about Local Socio-Ecological Systems.” *Journal of Science Education and Technology* 34 (2): 215–235. https://doi.org/10.1007/s10956-024-10152-6.

Learning in Places Collaborative. 2020. *Framework: Socio-Ecological Histories of Places Framework: Supporting Sense-Making and Decision-Making*. Bothell, Seattle, WA and Evanston, IL: Learning in Places.

Lim, M., and A. C. Barton. 2010. “Exploring Insideness in Urban Children's Sense of Place.” *Journal of Environmental Psychology* 30 (3): 328–337. https://doi.org/10.1016/j.jenvp.2010.03.002.

Lupi, G., and S. Posavec. 2016. *Dear Data: A Friendship in 52 Weeks of Postcards*. Princeton, NJ: Princeton Architectural Press.

Manz, E., R. Lehrer, and L. Schauble 2020. "Rethinking the Classroom Science Investigation." *Journal of Research in Science Teaching* 57: 1148–1174. https://doi.org/10.1002/tea.21625.
Metz, K. E. 2011. "Disentangling Robust Developmental Constraints From the Instructionally Mutable: Young Children's Epistemic Reasoning About a Study of Their Own Design." *Journal of the Learning Sciences* 20 (1): 50–110. https://doi.org/10.1080/10508406.2011.529325.
Mitchell, K., and S. Elwood. 2012. "Engaging Students through Mapping Local History." *The Journal of Geography* 111 (4): 148–157. https://doi.org/10.1080/00221341.2011.624189.
Mitchell, L. S. 1991. *Young Geographers: How They Explore the World and How They Map the World*. 4th ed. New York: Bank Street College of Education. https://educate.bankstreet.edu/books/10.
Nespor, J. 1997. *Tangled Up in School: Politics, Space, Bodies, and Signs in the Educational Process* (e-book.). London: Routledge.
Sandoval, W., J. Kovach, L. Perez, L. Kim-John, and J. Kawasaki. 2023. "Using Argument to Reason About Science Practice: Students Can Productively Argue about a Lot More than Just Claims and Their Evidence." *Science and Children* 60 (7): 54–57. https://doi.org/10.1080/00368148.2023.12315939.
Schenkel, K., C. J. Brownell, and J. M. Wargo. 2024. "Children Communicating Care Through Curiosity Walks: Using Scientific Practices to Cultivate Knowledge about Climate Justice." *Science and Children* 61 (2): 76–82. https://doi.org/10.1080/00368148.2024.2315670.
Schrauben, M., A. McCulloch, K. Renfrew, C. Zembal-Saul, and P. Bell. 2021. "STEM Teaching Tool #72: How Can Arguing from Evidence Support Sensemaking in Elementary Science?" https://stemteachingtools.org/brief/72.
Van Wart, S., K. Lanouette, and T. Parikh. 2020. "Scripts and Counterscripts in Community-Based Data Science: Participatory Digital Mapping and the Pursuit of a Third Space." *Journal of the Learning Sciences* 29 (1): 127–153. https://doi.org/10.1080/10508406.2019.1693378.

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