What Your Colleagues Are Saying . . .

"*Place-Based Science Teaching* ignites a powerful vision for science education—rooted in local context, real-world relevance, and student curiosity. Written by National Board Certified Teachers, it's packed with classroom-ready ideas and inspiring stories that show how reimagining the learning journey can spark deeper learning and lasting impact. A must-read for educators ready to transform science teaching!"

Peggy Brookins
President & CEO, National Board for Professional Teaching Standards
Arlington, VA

"In our increasingly indoor-, media-, and technology-focused world, reconnecting young people to the environment has never been more important. This book is both a catalyst and a passionate practicum to do just that: grounding science education in the natural and cultural landscapes of home."

Thor Hanson
Author, *Close to Home: The Wonders of Nature Just Outside Your Door*
Friday Harbor, WA

"*Place-Based Science Teaching* offers a transformative approach to education. By deeply connecting students to their curriculum, community, and planet, this insightful guide showcases the authors' critical analysis and tremendous creativity. The book's practical and inspiring strategies empower educators to nurture student agency and a much-needed sense of care for our world, giving me great hope for the future of science teaching."

David Upegui
Science Teacher, Central Falls High School
Adjunct Lecturer, Brown University
North Providence, RI

"Everything I know about place-based learning, I learned from Whitney Aragaki. She opened my eyes to a world in which honoring place, histories, and personal context is centered and celebrated with humility and humanity. For educators feeling the isolation that technology can sometimes create, this reading will inspire new possibilities—reimagining online spaces with a place-based approach that celebrates community and honors life experiences."

Starian Porchia
Community Builder, Designer, & Consultant
Anna, TX

"This powerful resource provides a multitude of entry points and classroom-tested strategies for place-based science teaching. Not only a resource guide, this book also challenges the traditional notions that science teaching and learning are neutral. A must-read for social justice–oriented science teachers!"

Kimi Waite
Assistant Professor of Child and Family Studies,
California State University, Los Angeles
Coauthor, *What Teachers Want to Know About Teaching Climate Change: An Educator's Guide to Nurturing Hope and Resilience (Grades K–12)*
Los Angeles, CA

"As a teacher who strives to connect my students with their world, this book is extremely useful. It provides ways for my students to learn science through authentic interactions with nature and people in our community."

Amanda Clapp
Teacher Leader, The Catamount School
Sylva, NC

"This book provides clear and convincing evidence of how place-based learning helps students develop a deep knowledge of local environments and their relationships with them, strengthen their ties to the community, and foster the agency to solve real-world problems. Each chapter provides powerful frameworks, lesson-ready tools, and richly detailed cases of science teachers around the country who are engaging their young learners in diverse and holistic forms of placed-based inquiry."

Mark Windschitl
Professor of Science Education, University of Washington
Seattle, WA

"A well thought out book that brings place to its rightful spot in learning by looking at what and who was there, with an eye to honor those before while maintaining it for the present and beyond."

Melissa Hockaday
AIG Teacher, Wake County Public School System
Cary, NC

"Place-based science immerses any science class in real-world applications for students. No longer will students ask, 'When am I ever going to use this,' since they will be using their (k)newfound knowledge wherever and whenever they are."

Deanna McClung
Science Department Chair, Chemical Hygiene Officer,
HS PLTW Coordinator, Elkhorn Area HS
Elkhorn, WI

"Aragaki and Milks invite educators to redraw their maps—not just around textbooks and test scores, but around the texture of home as well. This book will inspire teachers, transform pedagogy, and have a profound impact on students' lives."

Bryan A. Brown
Kamalachari Professor of Science Education, Stanford University
Stanford, CA

"As an educator of color, I have long searched for authentic resources that center culture, community, and justice in ways that go beyond performative land acknowledgments or one-off lessons. *Place-Based Science Teaching: Connecting Students to Curriculum, Community, and Caring for Our Planet* is a call to action and a guide for educators to lead with culture, justice, and humanity at the heart of science. It invites us to reclaim science as something that lives in our communities, in our stories, and in our relationships to place."

Leena Bakshi McLean
Founder, STEM4Real
Author, *STEM for ALL: How to Connect, Create, Cultivate STEM Education for All Learners*
Honolulu, HI

"An essential, resource-abundant guide for more meaningful, relational, and authentic place-based science education. Nurture your science instruction through grounding, spirit, accountability, intentionality, and importantly: criticality."

Jerad Koepp
2022 Teacher of the Year, Washington
Native Student Program Specialist, North Thurston Public Schools
Rainier, WA

"Aragaki and Milks offer a powerful case for place-based learning as an essential tool for navigating today's polycrisis. By honoring identities, histories, and lived experiences, they invite educators and students into inquiry around a more expansive view of knowledge. This book is both a toolkit and an inspiration, encouraging reflection on our relationship with place and affirming our stories as critical testimonies. It is capable of sparking and sustaining action for a more joyful and just future."

Jothsna Harris
Founder, Change Narrative
Twin Cities, MN

"The power of this book is felt from its very first sentence, posed as a question to unlock the power within us: *What if the way forward is just under our feet?* This question encourages educators to think holistically about how we can expand our connection and humanity through place-based science practices. This book is the way forward, recommitting us to lifelong learning through curiosity, wonder, and awe of the natural world!"

Juliana Urtubey
2021 National Teacher of the Year
Phoenix, AZ

"The work I do every day is founded in place-based teaching and learning, and few people have taught me more about how to do that well than Whitney Aragaki. Her vision for education rooted in place is both revolutionary and anchored in ancient wisdom. Aragaki and Milks have written the essential guide to the future of place-based education, which is truly the heartbeat of any valuable education at all."

Ashley Lamb-Sinclair
National Geographic Explorer
Founding Partner, 2892 Miles To Go
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"Aragaki and Milks root science education in the richness of local context and community wisdom. Their approach not only deepens student engagement and builds critical problem-solving skills but also rekindles the joy and purpose that initially drew many of us to teaching. Grounded in decades of classroom experience and research, they provide educators with the tools to cultivate students who can meaningfully connect science learning to the world they will inherit and shape."

Kristin Cook
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Place-Based Science Teaching

To our places, our students, our communities, our future,
and our shared sense of wonder.

Place-Based Science Teaching

Connecting Students to Curriculum, Community, and Caring for Our Planet

Whitney Aragaki

Kirstin J. Milks

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online resources

Visit the companion website at **https://companion.corwin.com/courses/PlaceBasedScience** for an online chapter and a free online book study guide.

Note From the Publisher: The authors have provided web content throughout the book that is available to you through QR (quick response) codes. To read a QR code, you must have a smartphone or tablet with a camera. We recommend that you download a QR code reader app that is made specifically for your phone or tablet brand.

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*Natalia and Lauren's stories appear in our bonus chapter on place-based teacher mentoring, available at
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Preface

What if the way forward in education is just under our feet?

On a spring afternoon in San Diego, sitting outdoors at an educational conference, Kirstin and Whitney delightedly realized that the work we were each doing in our high school science classrooms was deeply resonant. We had met online through science professional development experiences years before, but this was our first time being in physical space, in person, together. We laughingly noticed that Whitney, who is from Hawai'i, shivered when the sun fell behind a cloud, while Kirstin, who lives in Indiana, basked in the warmth of longer daylight. It was a happy reminder that, even though we were finding incredible connections and overlap in our work, we teach different courses to different students at different schools in very different places. What fun to have our footing so far apart, yet so close together!

The connections we make to our places make teaching fun, meaningful, and exciting to us and our students. We're both driven by the goal of co-constructing a more hopeful and abundant future—and, although the goal is daunting, we're enjoying working on it and excited to share what we've learned with you.

Why Place-Based Teaching?

The book you're reading came into being because we've realized that place-based teaching is a vital answer for challenging questions about teaching and learning science that matter both in the here and now and as we look to tomorrow:

- How can we intentionally create science education that builds authentic, transformative opportunities for deepening engagement, strengthening the communities our schools serve,

and actively developing problem-solving skills in the face of an uncertain future?

- How can we leverage the rich and varied knowledge held by everyday people, both past and present, about the places we call home?
- How can teachers begin today to support young people in making a difference, for each other and for generations to come?
- And, equally important, teaching can be a challenging gig, both cognitively and emotionally. How can we help teachers themselves feel more joy, fulfillment, and a sense of exploration in their teaching?

In *Place-Based Science Teaching*, we offer a comprehensive exploration of place-based teaching, presenting a guide that gets to the heart of how centering education in place provides important motivation and agency for students as they learn science, create community, and take action. We want this book to help you love your role in education, whether you're a K–12 classroom teacher, instructional coach, science supervisor, administrator, informal educator, scout leader, homeschooling family, education professor, or teacher candidate—and we know the ideas in this book can help!

We're nationally recognized high school science educators with over thirty years of classroom experience between us, so you'll find this book rooted in the work we've done with students through the incredible social, political, environmental, and technological changes of the past two decades. We've each been at the forefront of educational transformation, partnering with high-leverage organizations across the United States to reimagine how education can best serve students, teachers, and communities, so you'll find we draw on local, national, and global perspectives. We're both National Board Certified Teachers and Presidential Awardees for Mathematics and Science Teaching, and Whitney is a National Teacher of the Year finalist. This means we understand high-rigor instruction, as well as the gorgeous and powerful knowledge that educators generate in their classrooms as they learn to create it. Finally, we each hold PhDs, Whitney in education and Kirstin in biochemistry, so we bring a love of informing our roles as teachers, researchers, writers, innovators, and investigators with the scholarship of the giants on whose shoulders we stand.

As a result of that last value, we designed this book to reflect ideas from across the growing movement to leverage place in science teaching

and learning. We're excited to introduce you to our wonderful friends, award-winning educators who are highlighted collaborators in this work and have contributed stories from across our nation to this book. Throughout the country, our teacher friends have experienced the power that place-based learning holds for students, from large cities to rural areas to the suburbs in between. We are not the only folks working on this, and this book isn't meant to be the last word on place-based teaching in science, but we hope you find what we are sharing useful in your own teaching and learning.

Our Goals for This Book

1. We want to help you build science learning opportunities that are meaningful for both you and your students, and we want to help you leverage your existing interests, wisdom, and experiences. We want this book to support you in developing your practical and theoretical knowledge of place-based learning, as well as jump-start your imagination with ideas and quick tips you can use in school tomorrow. Teaching this way has transformed our classrooms, and we know it will be transformative for you too.
2. We both believe that teachers generate vital wisdom about their contexts, and we don't want to prescribe lesson or unit plans that assume that one size fits all. Instead, consider this book an invitation to imagine, design, and engage in playful discovery.
3. We also want to help you love the important work you do! We've found that place-based teaching has helped us actively enjoy our time in the classroom, even when there are substantial bumps in the road. Place-based teaching can be great fun, whether you are just beginning by incorporating some of our strategies or leveraging your experience to connect your students with organizations and learning beyond the walls of your classroom. We've also found that place-based learning can recenter students in their own communities in ways that build empathy and collaboration within classrooms, as well as between adults.
4. We invite you to consider place-based teaching as a tool for helping to grow a brighter, more hopeful future. We can help students build personal investment and relevance in their learning, as well as develop Next Generation Science Standards (NGSS)–aligned authentic problem-solving and critical reasoning skills—exactly what our next generations need in order to thrive.

One quick note before we move on: We want to be clear that you do not need to be an "outdoorsy" person to teach this way, nor do you need to be someone who currently holds a great deal of knowledge about the place where you teach. We'll talk more about why later in this book; for now, know that you and your students are already bringing important knowledge of place to your learning together, even if you don't yet know it!

How to Use This Book

We know some readers prefer to skip around inside a text, while others work from start to finish, and we've written this book so you can do either! To help you customize, here's a brief overview of what you'll find inside:

- In Chapter 1, we'll introduce our framework for place-based science teaching in the bigger picture of scholarship on teaching and learning. By briefly highlighting important foundational principles and classroom approaches of this transformational science teaching methodology, we'll help you connect your work to best practices and provide evidence to explain how taking kids outside or going off-script from an established curriculum can be an incredibly high-impact instructional decision.
- Looking for classroom-ready inspiration for incorporating local context, relevance, and stewardship into your teaching? In Chapters 2 through 5, we'll take you behind the scenes in our classrooms, detailing high-impact, standards-aligned activities and sharing educator stories from diverse educational settings. You'll see how place-based science teaching fits into your teaching practice using our simple, yet powerful, framework.
- Finally, Chapters 6 and 7 take our conversation on place-based learning and teaching into various educational spaces and ideas, including virtual learning environments, the definition of land, and the future of education. Note that we include a free bonus chapter on place-based teacher mentorship available at https://companion.corwin.com/courses/PlaceBasedScience. By exploring innovative strategies and emerging trends in these chapters, you'll be equipped to adapt and evolve your teaching practice in response to changing educational and social landscapes.

Features of the Book

Who doesn't love a little built-in reflection and guidance throughout a lesson? Teachers sure do! Here's what you'll find in this book to support your learning:

- **Hint:** A short, specific recommendation for how to put ideas into practice.
- **Try It!:** An activity for students and other learners (maybe including you or your teaching team).
- **(K)new Invitation:** As you'll learn in Chapter 1, *(k)new* is increasingly synonymous with place-based innovation, inviting the fertile knowledge of our ancestors into twenty-first-century solution spaces (Edwards, 2009). In this book, we've provided metacognitive writing/journaling exercises that encourage connection and (re)membering (in this case, helping you better understand how you are a part of important systems, groups, and histories) through this lens; these are aimed at teachers, students, or sometimes both.

Hint

We know that it can be hard for teachers to find the time to reflect formally, but reflection is an amazing power-up! Consider using the Notes app on your phone and/or leveraging voice-to-text for on-the-go, low-barrier ways to capture your thoughts. Alternatively, you might find that just the right notebook (or sketchbook, if you like to draw or sketchnote) can feel like a safe home for your thoughts without the constant distraction of technology.

Self-Awareness, Personally and Professionally

We are in places at all times. Our connections to these places are multi-faceted and layered with the experiences we have individually and collectively. This means that place-based teaching requires an awareness of our own practices and perspectives, both personally and professionally.

Author Positionality

To help model this stance as learners and teachers ourselves, here are short acknowledgments of our own identities in our own words. Each

of us has a different story to tell, so we'll identify places in this book where one of us is writing about our own experiences or perspectives.

Whitney

I identify as a female *gosei* in Hawai'i. Over the years, and in different social circles, I have contemplated to what extent I liken my culture to Japan or the United States. At this time, I choose to acknowledge my positionality through time and place because it is equally important to my ancestral geographic land. *Gosei*, translated from Japanese, means fifth-generation diasporic from Japan.

My ancestors left Japan during heights of imperialism and sought refuge on Hawai'i Island. While I do not denounce my Asian settler privileges, many generations have passed inasmuch that I have no connection to my ancestral lands in the Western Pacific. My family's diaspora from Japan has been long since, yet I acknowledge our (both family and extended cultural community) settler colonialism in Hawai'i and am continuing to understand its effects on our community and land.

Reflecting on my own learning journey as an adolescent, I saw science as my way out. In high school, I imagined the glory of leaving my small town in the Pacific and becoming somebody in a big city, dreaming of bigger and better ends. In Pennsylvania, I dabbled in engineering and computing. Yet I found solace in biology and conservation, topics that centered around the places I left. Science became my way back home. What I had been running from made me who I am. When I was distant from familiar biodiversity and cultural stories, I discovered my purpose and passion in education and place-based teaching practices. I am a product of my place, of the cultures that raised me, and the community that built my knowledge and resolve.

The Hawai'i where my ancestors docked in the late 1800s is a far cry from the Hawai'i my children and I know and learn from. As a science teacher, I reflect on the many ways in which science, especially biology, has been used to estrange and isolate people, identities, perspectives, and inquiry. My goal as a teacher is to reframe the ways we view and define knowledge in schools. As we invite other ways of knowing and being, may we all joyfully exist in our classrooms, communities, and our own minds.

Kirstin

I am a partner, parent, family member, and friend. I'm also a high school science teacher and Girl Scout volunteer who lives and loves in Bloomington, Indiana, a place that was and continues to be tended by

Native peoples as well as newcomers. When I was a young person, my family experienced devastating poverty and instability. This helped me appreciate the many ways that students, teachers, and communities can work together to create opportunities in educational spaces for refuge, creativity, joy, and resilience.

My relationship with land and place is complex. I identify as a white person for whom my Haudenosaunee ancestors' traditions and values around land have not been present due to terrible oppression and violence against the First Peoples of my father's side, and I am intentionally working to learn more about ancestral ways of understanding human relationship with the natural world.

I grew up in and around Albany, New York, where my mother planted and tended gardens throughout her intense struggles with mental illness and where the grandeur of the Eastern temperate forest seemed but a memory stored in the scrub trees that sprouted up in highway medians. I grew up believing land is something that provides, something for people to mold and shape and use up. Even when I moved to breathtakingly beautiful Northern California to study biochemistry, my view of the land was centered in human use.

It took relocating to a much more rural part of the world for me to begin to understand that humans are not apart from the ecosystems in which we reside. In my adopted Midwestern hometown, I began to learn how humans have influenced ecosystems in ways that put future generations at tremendous risk. At the same time, my students and I started to investigate how to center our AP Biology and Earth & space science curricula in place as a way to build ecological optimism and climate hope, drawing on an increasingly nationwide knowledge network of teachers and students collaborating on similar goals. I hope that our learning will help you center place in your and your students' learning journey, and find some unexpected happiness, fun, and fulfillment in your classroom along the way.

Uncovering Your Positionality

Positionality work is a practice that supports one's own self-learning in preparation for place-based learning and teaching. It's the idea that our values, perspectives, and locations in time and space impact how we understand the world. We've learned from students' and our own experiences that identities like social class, family role(s), gender, and race are not just indicators of how people think about land and human relationship with place, but are also used to navigate our life's experiences in our communities.

JOT THOUGHT

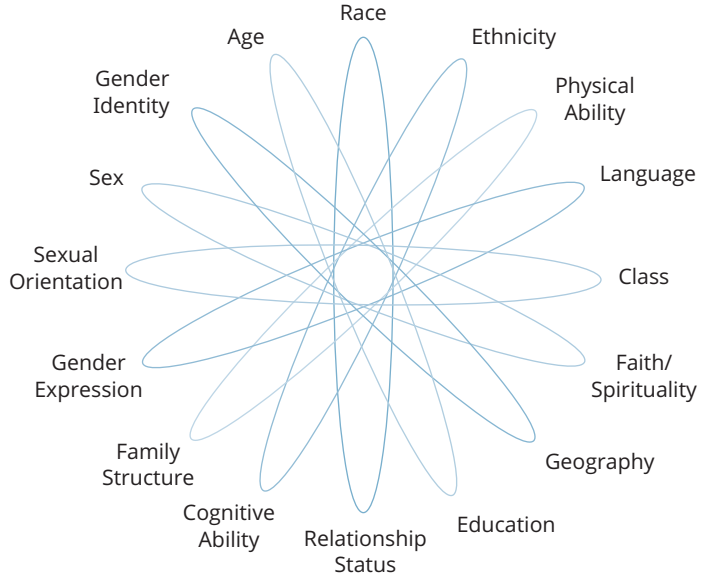
https://qrs.ly/p8gm2fk

To read a QR code, you must have a smartphone or tablet with a camera. We recommend that you download a QR code reader app that is made specifically for your phone or tablet brand.

We'll talk quite a bit, later in this book, about how identity and place are tightly connected and can be leveraged to deepen science learning for students. For now, however, we want to introduce an exercise that will allow you to explore your own positionality here because we know that it will support you in starting or deepening place-based learning in your teaching context. It might also help you begin to think about the perspectives of different people who have held power and determine how land is used, by whom, and to what ends.

Sometimes, introductions of positionality include taking inventory of your many overlapping identities, such as age, race, ethnicity, physical ability, etc. (Equitable Teaching, n.d.; see Figure P.1 and linked resource at the QR code).

Figure P.1 The dimensions of identity



Source: Hollins-Alexander & Law (2022).

These are great ways to get started! We like how the prompts in the activity that follows build on these dimensions by asking us to seek out where and how we can concentrate our efforts for making the world a better place. Keep in mind that identities can be static and dynamic.

Some pieces will define us for our lifetime, while others will change with new or deepened experiences.

Exploring positionality pulls us to think about the responsibilities that are nestled within our identities. How will we use our societal privileges to ensure all people are seen, respected, and honored? How will we use our struggles to understand the experiences of others? Additionally, how can we maintain the awareness of our biases as we move forward?

NOTES

TRY IT!

Write a Positionality Statement

GOAL

To explore your positionality through reflection on your individuality as a prelude for place-based learning.

DESCRIPTION

1. Try these brainstorming questions modified from *Intersectional Environmentalist* (Thomas, 2022) to explore your own positionality:
    a. What identities do I hold? *What are my values, beliefs, role(s) in family and/or community, ethnicity, gender, and culture?*
    b. What brings me joy? *What gives me life? What gets me up in the morning?*
    c. What am I you good at? *What are my talents, special skills, network, resources, and privileges?*
    d. What needs to be done? *What's the work that's available to me and only me?*
    e. What are the communities I'm a part of? *As intersectional humans, we are each a part of many ecosystems, both literal and figurative. What are mine?*

EXTENSIONS

This exercise is a great gateway to change-making, for both educators and their students. Consider gathering a team of teachers to work through these prompts, then share as part of your brainstorming process. Similarly, positionality practice can be joyful and helpful for learners of any age, especially in helping team members with differing viewpoints or values feel heard and respected. Your students' age or grade may influence how you narrow or widen the scope of personal identity and responsibility you ask students to develop.

REFLECTION

Conversations about who we are, and our collective responsibility as framed as members of a classroom and/or greater community, can be joyful, helping young people uncover what they want for their future and building relationships that foster high-quality learning. Here's an example of a positionality statement from one of Whitney's students:

> *I am a female Pacific Islander, though my ethnic background isn't the only thing that makes up who I am today. My*

environment played a huge part in who I am. Though I am of Palauan descent and am more Palauan than Hawaiian, I identify more with my Hawaiian side since I have lived here in Hawai'i. I did get from my dad and mom my religion of Christianity. I acknowledge my privilege to be able to practice my religion in a country that is made up of mostly Christians. To be able to practice their beliefs comfortably is something that I'm very fortunate to be able to have. As a proud Hawaiian I know that living on an island makes it hard to get resources. As a result, everything that needs to be shipped in is extremely expensive. Being sustainable is important for a small island. As Hawaiians, and people who depend on living here, we need to be able to make it livable. Growing our own food will help us to stay local and not have to rely on outside shipment, but it'll also help us to connect with each other. I want to be a teacher, help people, and make a difference in my community. Embracing our culture by growing our own food and going back to our roots is key in bringing everyone together and creating a better future for our keiki [children]." (Maya, 17)

NOTES

A Few Notes on Language

Throughout our work, we both seek to use language in keeping with current efforts to communicate complex ideas about history, belonging, and perspective.

- We'll use the self-descriptive language that our collaborators prefer, whether that's, for example, Latinx or Latine, or utilizing differing capitalization in people's names and identities.
- This book includes stories containing culturally significant words or phrases that may be unfamiliar to you; we'll always define them when they're first used.
- You'll also find that, inspired by (k)new invitations, we'll sometimes encourage a certain interpretation of a familiar word by using parentheses. Examples include (re)membering and (be)coming as we rethink our ideas about community and belonging.
- In this book, we use the phrase **ancestral knowledge** to refer to the wisdom that people connected to the past and more traditional ways of living in kinship with land have held. Sometimes this knowledge's origin is ancient, and sometimes it's uncovered by much more recent observers and innovators.
- The phrase **minoritized** is an adjective that describes a group of people who, as a result of bias, history, and/or oppression, have less power in society and/or are under-represented in decision-making compared to other groups. Sometimes, these groups are not in the minority, but they do not have a proportional share in power or decision-making. This is related to the phrase **underserved**, which we use here to describe groups who are disadvantaged because they do not get the same resources or access to those resources as other groups.
- We've shifted to using the term **participatory science** to refer to what has been known as citizen science; this shift in perspective helps us understand that all members of a community, including those who hold citizenship beyond our country, can generate important wisdom about the natural world.

Land Acknowledgment

The National Academy of Sciences' report on *Equity in K–12 STEM Education* (2025) highlights the importance of place as a necessary resource for STEM learning and makes it clear that, just like knowing a language, the vitality of knowing the lands and waters of our communities

holds cultural power and support resilience in even our youngest learners. We want to note that our understandings of the importance and nuance of place help us make instructional and professional decisions, both in our classrooms and throughout this book. At the same time, honoring the plurality of unique human experience is a part of place-based learning for both students and their educators. To that end, we would be remiss not to include our own acknowledgments to the land itself in this book. More on this practice and how you can bring it to your students in Chapter 1.

Recognizing the broadness of land and water while honing in on the specificity from which we individually benefit is a difficult task. However, we accept the beautiful responsibility to try, in our best effort, to dually seek inclusivity and localization in our words and actions, and to work to repair and restore when our efforts fall short.

Our acknowledgments are woven into our stories, specific to Whitney and Kirstin, throughout this book. We also understand that any acknowledgment we make must not be performative or a box to check off. Our responsibility to act in reverence and mindfulness holds us accountable in the work we do.

We honor the land, waters, and Native and Indigenous peoples who persist and hold knowledge that we benefit from. We acknowledge the land that was stolen and reshaped to build the foundation of this country in which we continue to work, learn, and play. We acknowledge our collective debt to peoples, both long of these lands and more recent, whose labor has been forced and knowledge has been exploited. Economic growth and development on these lands throughout history has been made possible by the labor of enslaved and undercompensated peoples. We honor the laborers with origins from across the globe who transformed and are transforming labor laws and unions, as well as the migrant workers who continue to work the farms that feed our nation's people.

Land holds memories, and we acknowledge that the names we use to refer to places come with history behind them. After all,

> *Places, like people, have genealogies. Place names serve as historical genealogies, chronicling the changes that have occurred over time in a particular locale . . . In studying places, it is therefore very important to acknowledge the names bestowed on various places and to understand how and why names are selected and what traditions and histories are attached to each name.* (Olivera, 2014, p. 78)

Place-based teaching advocates for honoring the names of places and peoples who are working for a just future. In this book, our goal is to share and credit the voices of students, teachers, communities, and places that are responsibly highlighted to the extent possible, using individual names with permission when this applies. We note the irony of academic systems' insistence on pseudonyms to protect our students and places, forcibly erasing from published educational scholarship the names of the places and schools—often named specifically and thoughtfully for the places that feed our learning spaces and community. As we do this work, we are straddling these worldviews where regulations are put into place to protect vulnerable peoples, and yet must recognize the harm caused when people's wisdom is insufficiently credited.

Learning is holistic, yet too often students are asked to leave parts of themselves at the door. Let us activate the hearts and minds of our students through an immersive context that honors our places and people. Our students, our children, and we learn deepest in this way. We teach with aloha and joy. Not just the practice of kindness or welcome, but the reciprocity of reverence with land and people. Teaching is the calling to empower a sense of responsibility in students to learn and create meaningfully in partnership with our communities. Join us.

Acknowledgments

We are both thankful beyond measure to the Corwin team and in particular our editor, Debbie Hardin, for her encouragement, keen eye for detail, and outstanding organizational prowess, especially in the face of the unmitigated chaos that is supporting teacher-writers during the school year. This book exists because Debbie is passionate about helping teachers craft a brighter future, no matter what challenges tomorrow may bring. We also want to honor the wisdom and generosity of the many teachers and students who shared their stories and work with us.

Whitney: Thank you to my parents for insisting that I know the names and stories of each *mauna*, *pu'u*, and shore break around Hawai'i Island. My resistance in childhoood only deepens my insistence to know now. Thank you for embodying *kodomo no tame ni*, in my own (ongoing) upbringing and for da boys. I am grateful for my current and former students and teachers who teach me and whose stories are woven into my own. To my *'Ohana* Bubble: Sarah, Melissa, Kimie, Rochelle, Chad, Kristen, Esther, tia, and Caitlyn, I am forever grateful for our friendships. And to Cody, Cole, and Ren, we are one step closer to our next journey! *Aloha nō*.

Kirstin: I am thankful to the following folks for teaching me: my amazing students and Girl Scouts, as well as their families; my colleagues in Bloomington, Indiana and across the country; the Educating for Environmental Change initiative at Indiana University Bloomington; the Climate & Equity program at TERC; the National Association of Biology Teachers; the Knowles Teacher Initiative; the Lilly Teacher Creativity Fellows; Dr. Val Brown and the wonderful cohorts she creates (including Whitney and me!); and my family and friends. Frank, Nemora, Therian, Jai, Sid, Jakob, Z, Mina, Haddie, Myrene, Jennie, and more: I love getting to be yours, and I'm so glad you're mine. Last, a special thanks to Dr. Jeannie Lythcott (1939–2025), who taught me how to teach and how to be, all at once. I am forever in your care.

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Whitney Aragaki is an educator, parent, and learner from Hilo, Hawai'i. She supports students to learn through a lens of abundance that honors place, people, and cultures. Her teaching focuses around con versations, practices, and systems that sustain the intimate interrelationship of public education, community, and environment. Whitney is a fifth-generation Hawai'i Island resident of Japanese ancestry. She is the daughter of two educators, and was a student in her mother's biology class. She currently serves as a high school science teacher at her alma mater, Waiākea High School, and as a professor of practice and faculty lead at Reach University. Her two children also thrive in this supportive public-school ecosystem. Whitney has a bachelor of arts in biology from Swarthmore College, a master of science in tropical conservation biology and environmental science from the University of Hawai'i at Hilo, and a doctor of philosophy in education from the University of Hawai'i at Mānoa College of Education. Whitney, a National Board Certified Teacher, is the 2022 Hawai'i State Teacher of the Year and National Teacher of the Year Finalist. She is a 2021 Presidential Awardee for Excellence in Math and Science Teaching and a 2023 Obama Foundation USA Leader.

Kirstin J. Milks teaches AP Biology and introductory science at Bloomington High School South in Bloomington, Indiana, where she also serves as a STEM team coach and mentor. Kirstin loves collaborating with students and community members to learn together in inclusive and responsive environments, as well as supporting and making public the work of teaching and learning—all with the goal of helping youth build a just and sustainable world. A graduate of Stanford University's Schools of Medicine (PhD) and Education (MA), she is a National Board Certified Teacher, a Presidential Awardee for Excellence in Math and Science Teaching, a Lilly Teacher Creativity Fellow, the 2025 president of the National Association of Biology Teachers, her Girl Scout council's Leader of the Year, and a Senior Fellow at the Knowles Teacher Initiative. She's worked with organizations including the MacArthur Foundation, the Carnegie Foundation, the National Science Foundation, the College Board, SXSW EDU, Educating for Environmental Change, and schools across the country to envision, engineer, and enact the future of education, with a focus on humane and socially responsive science teaching. When she's not teaching or volunteering with Girl Scouts, Kirstin enjoys visiting the library with her family, practicing all-ages taekwondo, and singing along at top volume to local radio.

1 A First Look at Place-Based Teaching Practices

Central Park in New York City.

Source: istock.com/dolphinphoto

In this chapter, we'll:

- Define place-based teaching
- Explain how place-based teaching requires self-awareness, both professionally and personally
- Discuss how place-based teaching is the same as, and different from, other approaches
- Situate place-based teaching in broader scholarship about teaching and learning

- Define Land Acknowledgments and why they matter, plus suggest classroom practices that engage students in the process of learning about and crafting their own Land Acknowledgments

Introduction to the Work

'O wai kou inoa? In Native Hawaiian, this common question is translated to ask, "What is your name?" *Wai*, in Hawaiian, can mean "who" in this question, but is also the term for "water." Thus, the question really asks, "From whose water do you flow? Of what waters do you come from?" (Wilson-Hokowhitu, 2020). In Hawaiian culture, the essence of who we are is innately connected with the places and waters that feed us.

Whitney lives in a large town on Hawai'i Island, close in proximity to an active volcano, abandoned sugar cane fields, and surf breaks. Kirstin resides in a small city nestled into a landscape of temperate forests, Midwestern cornfields, and limestone quarries. You might think these are very different places—and you'd be right! At the same time, our places are not so different after all. Both have been and are currently cared for by some of the people who live there. Both, too, have ways in which some people have not done a great job in caretaking their resident humans, plants, animals, and/or ecosystems. And, importantly, both have young people who call them home as they learn about the beautiful world they are to inherit and share.

What Is Place-Based Teaching?

The duality we just described is one of the many things we love about **place-based teaching**, which we define as the practice of students and teachers grounding their learning in the place where they live and love. Place-based teaching supports students' lived experiences and relates directly to physical and metaphysical features of place that students experience in their daily lives (Sobel, 2004). This means this way of teaching is accessible to learners and teachers across grade levels, content areas, and inclusion needs, from rural to highly urban settings.

We want to be clear that place-based teaching is not synonymous with outdoor education, in which students are physically outside (often in an area seen as more "natural"), or environmental education, which focuses more specifically on ecology and/or environmental science. These types of education are important, but place-based teaching is a more fundamental concept. When we lean into place-based teaching, we're simply shifting local environment and community from background setting to the main focus and/or context of our learning.

Place-based teaching helps learners see the unique splendor and rich history of their particular place on our beautiful planet, as well as see how

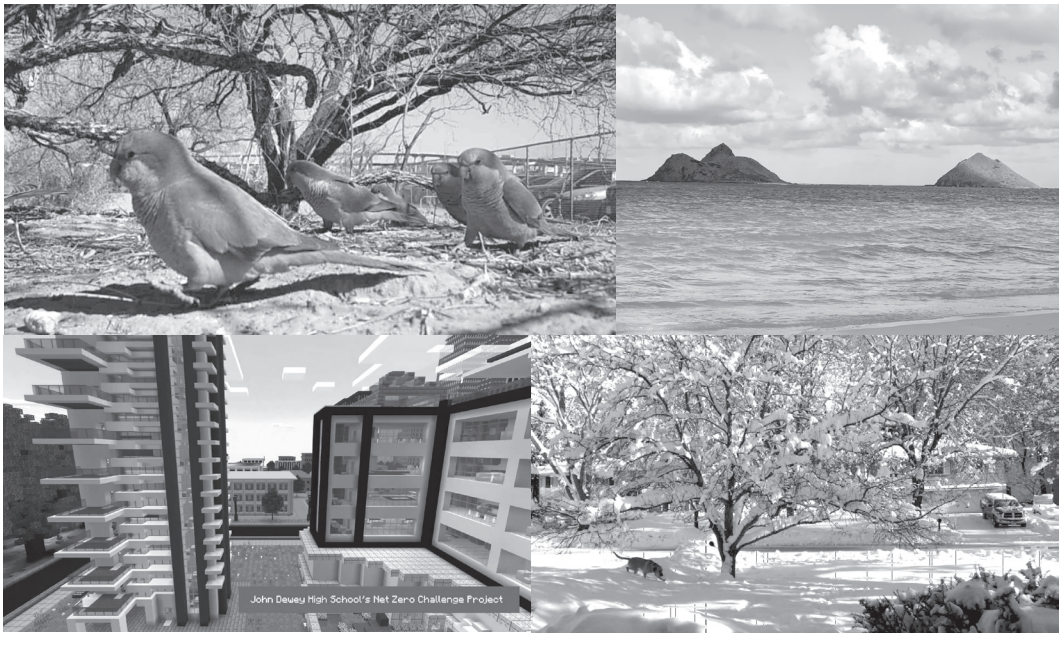
people and places are connected by similar stories of ecology, landforms changing over time, and human relationship with land and its inhabitants. This first (K)new Invitation, designed to kick-start this type of thinking, can be done as a personal reflection or with colleagues. We've also had fun using it to introduce lessons on developing scientific observational skills (NGSS crosscutting concept 1), generating scientific questions (NGSS science and engineering practice 1), or making predictions about land and place (NGSS science and engineering practice 7) (NGSS Lead States, 2013).

(K)NEW INVITATION

Places We Call Home

Think about the places you have called home or consider your home alongside another place in the world (Figure 1.1). What do you know or wonder about how these places differ? What do you know or wonder about how these places are the same?

Figure 1.1 Places We'll Explore Later in This Book



Source: Desert parrot photo by Ramon Benavides Jr.; Kailua Beach photo by Derek Minakami; Minecraft screenshot by Mashhfiq Ahmed; Minnesota snow photo by Natalia Benjamin

Tip

To help learners avoid making observations or predictions based on harmful stereotypes or incomplete knowledge, you can choose to focus student comments on a specific aspect of land history, landscape, or ecology. Another fun strategy is to start this process with one or more photographs from each place!

Why Is Place-Based Science Teaching Effective and Important?

> *"Our places shape the way we see and are in the world."*
> (Beamer, 2014, p. 56)

Place-based science teaching has been shown to be a high-impact method for supporting transformational learning! Studies on students' experiences in place-based learning result in increased science knowledge, increased plans for postsecondary STEM education and careers, higher graduation rates, and deepened science identity (Stansberry et al., 2023). Across formal and informal school settings as well as community-based summer camps, students engaged in place-based educational efforts demonstrated greater personal meaning in science and increased connection to their local community (Stansberry et al., 2023).

Equally important, place-based science education helps both teachers and students feel connected to their schools and communities. These connections are deep, real, rooted in authentic science learning, and provide opportunities for students and their teachers to learn more about the histories, currency, and the futures of the place they inhabit. Additionally, teachers who participate in place-based professional development have increased ownership in science education, greater confidence in the science content, and demonstrated self-determination through community engagement and involvement (Stansberry et al., 2023).

As you'll see, it's not just the place that matters in place-based teaching. Place-based teaching leverages the wisdom of people within the classroom space, the community, and the larger environment. When teachers highlight, remember, and amplify the knowledge

that exists in place, we are honoring those who live and care for the land. In many places, these stewards are the Indigenous and Native people, the original inhabitants of our cherished spaces; in others, we can lift up individuals and organizations that are working together to enact and celebrate policies and practices that lead to environmental richness, ecosystem diversity, and human flourishing.

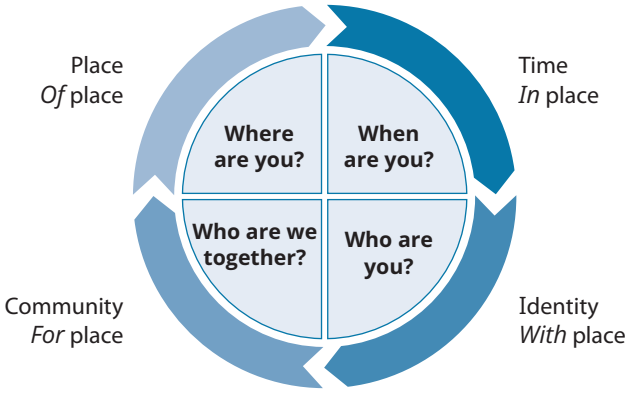
Students in place-based classrooms also become problem-solvers, taking on the challenge of finding new ways to take care of the places that we call home. Our position as science teachers and learners nests us within the interconnections of the natural world, and we share a responsibility to help our students see themselves as vital and woven into these interconnections within our classrooms, communities, and Earth. When we work with students to deepen our shared sense of belonging to our places, we also deepen a sense of responsibility to protect and preserve our places that continue to teach us.

Finally, through a practice of learning the stories of the land and skills and mindsets associated with sustainable futures, teachers open opportunities for their students to learn different, often hidden, cultural practices that have been intentionally erased from our typical classroom experience. We can show students that knowledge exists beyond textbooks and screens by inviting people of our places and their stories into our classrooms; this could be in-person conversations, virtual visits, or simple instructional moments that highlight science-related place-based stories or projects happening in your community. Thoughtfully highlighting the knowledge of community members has an added benefit too: it creates an argument that students and their families, by virtue of living in your community, hold knowledge that is valued and honored in formal learning spaces.

Four Questions of Place-Based Science Teaching

Your science teaching can explore place-based learning by asking the four questions we've developed to accompany the Place-Based Science Teaching Framework (see Greenwood, 2013; Gruenewald, 2003; Meyer, 2013; Smith & Sobel, 2010), which are shown in Figure 1.2 along with a helpful way to remember how students' studies connect to each.

Figure 1.2 Place-Based Science Teaching Framework Questions and the Studies of Place



Source: arrow image by istock.com/Abert84

Hint

This book separates these questions into four separate chapters, each with different activities to better illustrate how these different questions can be explored in the classroom, but we've found the best place-based learning combines two or more of these components!

Here's a quick overview at how learning outcomes in our own science classes inform each of these questions, plus a (K)new Invitation to help you map the knowledge you already hold about these ideas (we promise you already do, even if all of this seems new!):

QUESTION OF PLACE	LEARNING OUTCOMES, INCLUDING NEXT GENERATION SCIENCE STANDARDS (NGSS LEAD STATES, 2013)
Where are you?	– We focus on **NGSS science practices**, especially asking scientific questions, planning and carrying out investigations, and analyzing/interpreting investigations. – We strive to improve knowing of place, with the long-term goal of supporting the integrity of the environment, including land, water, ocean, sky, and native flora and fauna.

QUESTION OF PLACE	LEARNING OUTCOMES, INCLUDING NEXT GENERATION SCIENCE STANDARDS (NGSS LEAD STATES, 2013)
When are you?	– We focus on **NGSS crosscutting concepts**, especially exploring patterns, cause and effect, and stability and change. – We strive to incorporate ancestral knowledge and cultural vitality, strengthen relationships to place/land, and create awareness of time scales and change over time.
Who are you?	– We focus on developing students' sense of individual, family, and community **identity**, especially expressing their membership in multiple groups and community accurately and with pride without denying the humanity of other people. – We strive to support creativity and connection that improves the well-being, sustainability, and resilience of communities and natural environments.
Who are we together?	– We focus on **problem-solving and creative collaboration skills** like prototyping, iteration, and strong team communication. – We strive to create career readiness and community stewardship in areas of land stewardship, food production, energy self-sufficiency, technology, education, and other sectors that help to diversify the economy and natural security.

(K)NEW INVITATION

The Knowledge You Already Hold

Take a few minutes to make a bulleted list of short answers to each of the prompts below. Set a timer for no more than five minutes, if this helps. The goal is to capture as many ideas as you can in a burst of time. For each of the framework questions, we've given you a list of follow-up questions to help guide your thinking.

(1) Where are you? *Where is your place? What are its geographic features? How is land used there? What aspects of your place are built by humans? By nature? How do they interact? What kinds of plants and animals live there? What makes the physicality of your place special compared to other places? How does the place you live connect to the science content that you teach?*

(Continued)

(Continued)

Repeat the timer for each of the other three questions:

(2) When are you? *What do you know about the geologic history of your place? What about the civic or cultural history of your place?*

(3) Who are you? *What's important to you? Where and how did you grow up? What is your relationship to the place(s) where you've lived? (It's okay if your relationship status is "it's complicated!")*

(4) Who are we together? *What communities of people exist in your place that might be able to help you and your students make your place better? (Don't forget family and caregiver networks!) What do you know about how people have already worked where you live and/or teach to protect and honor land, plants, and animals?*

If you're so moved, pick one or more categories, set an eight- or ten-minute timer for each, and expand your thinking and questioning using stream-of-consciousness-style writing.

Last, look over your answers and jot some final notes: What excites you about what you captured? Did anything complex or confusing come up that you want to explore further? What questions will you explore next?

We've used variations on this journaling prompt with science teachers who are writers and storytellers to open avenues for exploration, with students as a powerful lesson opener, and in our own reflections on improving our teaching. You may choose to keep your writing private or share it with a community of practice or professional learning community. Whether you know a lot about a place or end up with more questions than answers, this record of your current knowledge can help you figure out what's next and can also serve as a tool for reflection along your place-based journey. We'll revisit this exercise at the end of the book!

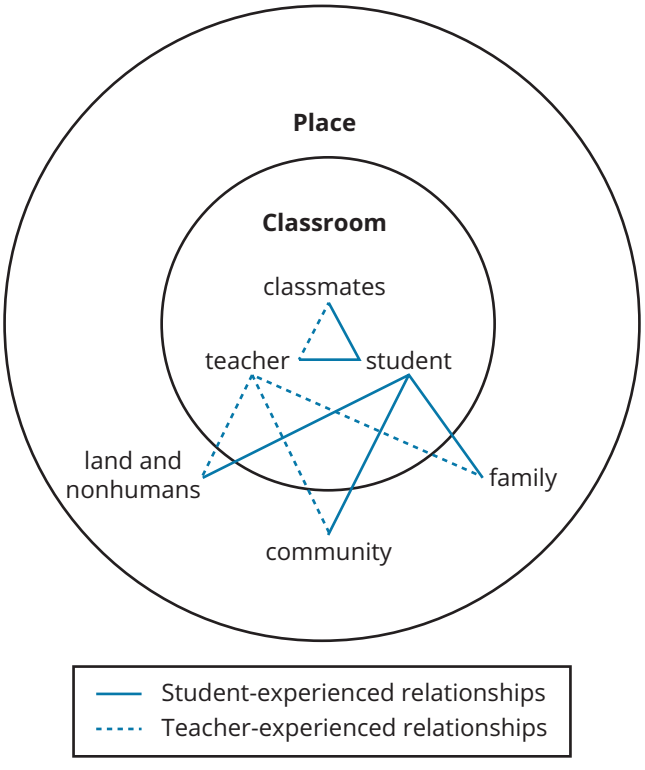
What Inspired the Place-Based Science Teaching Framework?

Let's take a quick moment to learn about the work by other teachers and scholars that we synthesize in the framework and corresponding questions. Throughout this chapter, we want to help you situate

place-based learning in scientific and educational scholarship traditions, including historical sustainability, scientific inquiry, relationality, access and belonging, and science teaching. We know that you as teachers need to be able to justify pedagogical choices to students, families, colleagues, and administrators; we'll share what you'll need to explain how a place-based approach is grounded in current best practices and scholarship about teaching and learning.

We begin with Whitney's scholarship, which articulates that our teaching practices are enlivened by the simultaneous relationships that exist between participants in our own classrooms and those that straddle the classroom through proximity to us (see Figure 1.3). Our connections, shown as lines in the artwork, illustrate the ongoing relationships in the classroom and the relationships that are maintained in and out of the classroom. Dashed lines represent the relationships the teacher holds, which may or may not be the same as the individual student.

Figure 1.3 Simultaneous Relationships in and Beyond the Place-Based Classroom Space



Engaging in a practice of place-based science teaching is work that designs for, is responsive to, and honors the simultaneity of relationships one holds as a member of a classroom, their family, the larger community, and as a steward of Earth. This diagram is a two-dimensional attempt to represent these simultaneous relationships that are neither linear nor cyclical. At times, our curricular focus will zoom closely into one of the many relationships that exist, and at other times, focus shifts to step back as we recognize the many ways in which we as humans operate in a wider perspective.

As she researched her PhD thesis, Whitney found several teaching frameworks that spoke to the connections she was uncovering in the literature and in her own teaching (Table 1.1).

Table 1.1 Teaching Frameworks That Inform Place-Based Science Teaching

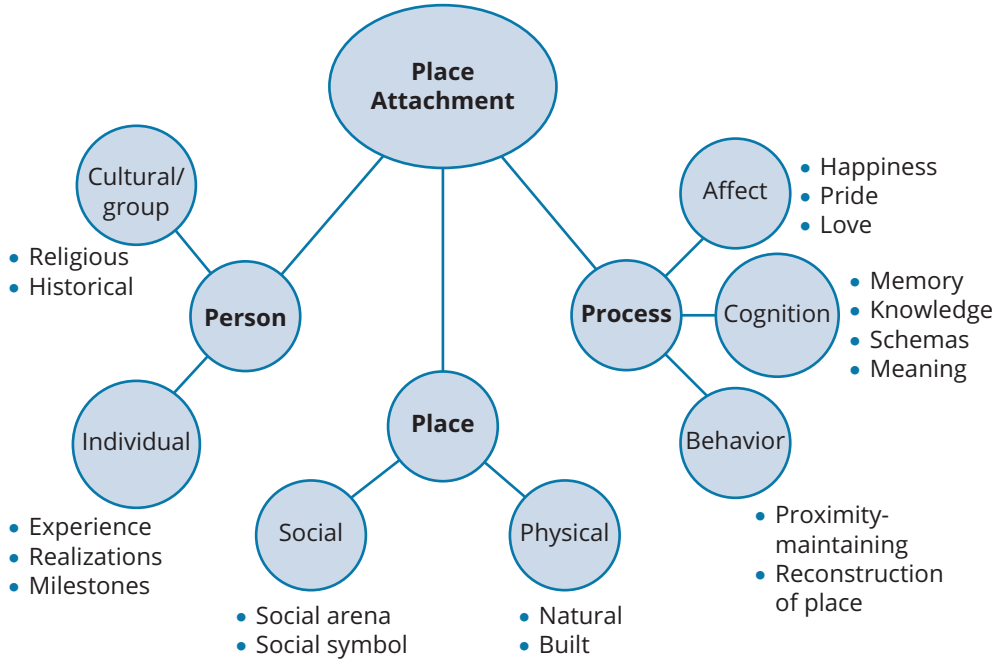
TEACHING FRAMEWORK	MAIN IDEAS
Sense of place	Place is a construct of place, person, and process. Sense of place includes communities, environments, and cultures as placemaking influences.
Sense of belonging	Place is shaped by power dynamics, identities, and histories. Consider relationships between people, place, and power.
Sense of responsibility	Place has an important role in shaping educational experiences and outcomes. Building a sense of responsibility fosters a sense of place and stewardship while addressing peace- and justice-focused solutions.

Sense of Place

In each place that we live, work, and play, we develop a specific sense of place. When we inhabit these places, there are experiences, actions, and thoughts within our bodies; feelings, and emotions that are conjured throughout these experiences. What helps people

develop that important "sense of place" and care for a particular part of our world? Scannell and Gifford (2010) found there were three components of attachment to place: place, person, and process; their ideas are shown in the concept map in Figure 1.4.

Figure 1.4 Place Attachment as Influenced by Three Factors: Person, Place, and Process



Source: Scannell and Gifford (2010).

Check out all the pieces that teachers can leverage to help their learners feel attached to a place! It's not just place itself; we also can think about the personal identities and experiences of our learners, in addition to the intellectual and emotional work that teachers do to craft great instruction. Scannell and Gifford's work helps us understand that each individual in the learning community brings their own experiences, backgrounds, knowledge, learning strengths, and perspectives, all of which influence how they engage with and perceive their educational environment (Figure 1.4).

Sense of Belonging

As science teachers, we strive for our students to find science identity, which is an important experience that can contribute to school and community belonging (Trujillo & Tanner, 2014). Research by Chen and colleagues (2021) underscores the importance of a sense of belonging in science, particularly for minoritized students, as stronger science identity supports their academic performance significantly. Additionally, Chen and colleagues' findings indicate that a sense of belonging in general has a greater impact on students with low science identity. We'll talk more about how to cultivate belonging in the coming discussion.

Sense of Responsibility

In many traditions of pedagogy of place, including those described by Gruenewald (2003), an important goal is helping learners developing a personal and collective commitment to becoming not only knowledgeable about their places but also deeply invested in creating a more equitable and sustainable future through problem-solving in their local context. Teachers can grow this sense of responsibility in their students by providing experiences in which individual learners' perspectives, passions, hobbies, and gifts can benefit our shared place.

Connecting Place-Based Science Teaching to Next Generation Teaching

Finally, we were also inspired to help other educators better understand place-based science teaching because it is a powerful lens through which to teach science transformatively. Expanding on the ideas we provided in Table 1.1, let's take a look at how we've updated the National Research Council's *Guide to Implementing the Next Generation Science Standards* (2015) to show how place-based learning can be used to build student engagement and aptitude (Table 1.2).

Table 1.2 Leveraging Place-Based Learning to Build Future-Focused Authentic Science Learning Through the NGSS

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:	LEVERAGE PLACE-BASED LEARNING BY ASKING:
Rote memorization of facts and terminology	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning	**Where are you?** **When are you?** Situate phenomena in your local context *or* as impacting your local context.
Learning of ideas disconnected from questions about phenomena	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned	
Teachers providing information to the whole class	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance	**Where are you?** **When are you?** **Who are you?** **Who are we together?** Help students explore local data and/or stories from local publications, governments, and/or other organizations to justify claims and design solutions.
Teachers posing questions with only one right answer	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims	
Students reading textbooks and answering questions at the end of the chapter	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students developing summaries of information	

(Continued)

Table 1.2 (Continued)

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:	LEVERAGE PLACE-BASED LEARNING BY ASKING:
Pre-planned outcome for "cookbook" laboratories or hands-on activities	Multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas	**Who are you?** **Who are we together?** Invite adults from your community as thinking partners for solving problems or serving as authentic audiences. Help students connect and extend their learning through collaboration and service learning with local government or nonprofit partners.
Worksheets (as final product)	Student writing of journals, reports, posters, and media presentations that explain and argue	
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Provision of supports so that all students can engage in sophisticated science and engineering practices	**Who are you?** **Who are we together?** Push back against the pervasive but often below-the-surface conception that only students who are going on to become scientists need high-quality, inquiry-based science education. Prioritize, scaffold, and offer feedback on student learning in ways that give all students access to the vital, productive ways of approaching the world that place-based learning can build.

Source: First and second columns adapted from National Research Council (2015).

We also acknowledge that teachers in elementary schools might be asked to focus more concretely in mathematics than in science education. Jackson and colleagues (2024) have connected many standards documents important in K–5 teaching into a list of integrated STEM practices (Figure 1.5); these practices map directly onto the activities and ideas we share in this book.

Wait, Is Place-Based Learning Another Way to Say Project-Based Learning?

The short answer is, it depends!

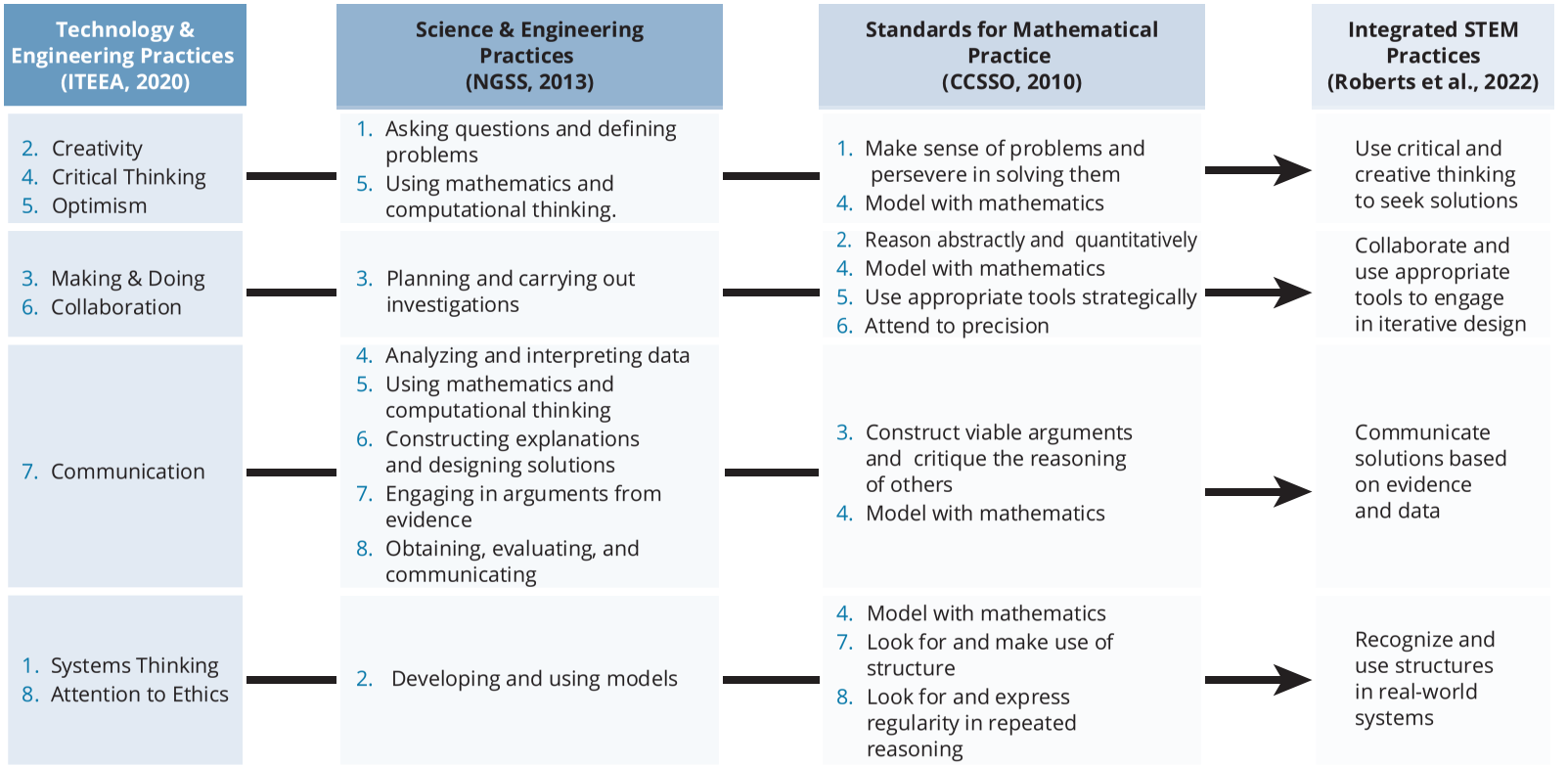
According to PBLWorks, a leader in the project-based learning model, "Project Based Learning (PBL) is a teaching method in which students work on a project over an extended period of time that engages them in solving a real-world problem or answering a complex question. As a result, students develop deep content knowledge" (Evans, 2019). In many ways, the *real world* referenced here is our place—our communities and environment. Project-based learning encourages students to focus their work on seeking solutions to complex questions or problems, then communicating their findings and innovations with a wider audience.

Both of us use PBL in different ways at different times throughout the school year, and we find that, with intentional planning of curriculum and instruction, it's an awesome method of helping students explore and care for their places. However, it's not the only method, and we both also incorporate high-leverage place-based science teaching strategies into more conventional classroom instruction. No matter the method you use to address any given learning target, place-based teaching intends to honor knowledge about place that students develop as active observers and participants in their own communities.

(K)new Invitations

How can we bring the knowledge of our ancestors to meet the needs and imagination of the present? The phrase *(k)new* is a way to mark this sort of place-based innovation, an opportunity to view this type of knowledge as both *known* and *new* (Edwards, 2009). It emerged from the work of scholars who studied the exploration and application of cultural memory and "common sense" knowledge of populations across the globe, from Finns (Kuokkanen, 2011) to the Māori (Edwards, 2009; Smith, 1999) to Native Hawaiians (Aluli-Meyer, 2006). In this section, we'll explore several aspects of this idea, but you'll find (K)new Invitation prompts throughout the book to help you reflect, grow, and innovate.

Figure 1.5 Integrated STEM practices



Source: Jackson et al. (2024).

(K)NEW INVITATION

Memories of Place

Close your eyes and think about places that have shaped you. What do you see? What do you smell? Are there sounds that are familiar? What emotions arise? Reflect in writing on what came up for you during this exercise, as well as any important personal discoveries. We've each used our own reflections from this exercise to help clarify our values, make choices about how we spend our time, and develop connections with the experiences of our students.

Within a given place, there are spatial imbalances of power and privilege. The exercise that follows asks teachers and/or their students to explore a particular place known to them, unpacking how different people might experience these imbalances and what solutions might be possible to define, design, and refine, as per NGSS science practice 6.

(K)NEW INVITATION

Experiences of Power in Place

Think about a place you've been recently and ask yourself, Who can walk or travel safely in the location? Who has access to ownership in the place and who does not? Who holds power over how this place or space is used or not used? Then ask yourself, Do we accept these experiences as normal? Are there ways that we enforce or resist these answers as teachers?

Example

Kirstin: When Whitney first suggested this prompt, my mind immediately jumped to a public park in my small city. Built on a former railroad switchyard, it's a place designed to be welcoming to all residents, including those experiencing extreme poverty. In the Midwest, where we are frantically fighting extreme heat in the summers, the park's design specifically includes cooling features like ample shade, great access to drinking water, and a free-to-use splash pad that is open and "lifeguarded"

(Continued)

(Continued)

during summer months. There are other humane features in the park's design, ranging from a variety of gathering places to accessible outlets to charge electronic devices, that are missing from other public spaces in our town. In a place and time when people experiencing extreme poverty are deeply separated from society, this reflection has inspired me to brainstorm ways that I might build a similar kind of oasis into my teaching. How can I help students reimagine inclusivity, both in public spaces and in public life?

Our individual and collective experiences in place contribute to common assumptions of what may be possible or not in these spaces. Unequal access to spaces creates banked memories that can perpetuate social order at the expense of others. Our histories have informed what we remember, believe, and can imagine in our places.

In many ways, contemporary science education has devalued Indigenous ways of knowing and Native intelligences (Aikenhead & Ogawa, 2007), minimized the contributions of historically underserved populations and communities (Philip & Azevedo, 2017), and pushed a political agenda (Rudolph, 2012) of a narrow culture in power in the United States. Part of our role as place-based teachers is to help students appreciate both the marvels of contemporary science and the wisdom of those who have come before us.

Knowledge

Knowledge has many definitions and many origins. Work through the activity that follows for examples.

NOTES

TRY IT!

Proverbs and Poems as Claims

GOAL

Use proverbs and poems as foundational scientific knowledge to guide potential investigations and practices to unpack data sources or case studies.

DESCRIPTION

1. Choose a proverb or poem that uses observations to make a claim that connects to the class lesson.
    a. Examples from *ʻOlelo Noʻeau*:
        i. The rain follows the forest (*Hahai nō ka ua i ka ululāʻau*).
        ii. The plover eats until fat, then returns to the land from which it came (*ʻAi no ke kōlea a momona hoʻi i Kahiki*).
    b. Examples from Africa:
        i. Where two rivers meet, the waters are never calm (Uganda).
        ii. What is inflated too much will burst into fragments (Ethiopia).
    c. Example from common US phrasings:
        i. When it rains, it pours.
2. In small groups, ask students to interpret the proverbs as metaphoric structures and as science observations.
3. Collect student experiences that contribute to their understanding of the proverb. If information exists, share the metaphorical meaning of such proverbs.
4. In small groups, ask students to list the types of data that would need to be collected to quantify these claims.
5. From the list of data, ask students to imagine what the graphs or figures that support this proverbial claim would look like. Give close attention to the units of measurement and the graphical display.

ADJUSTMENTS

If more examples are available, give each student group their own proverb or poem to unpack. If time and access allows, ask students to switch displays and conduct a gallery walk with glow/grow feedback.

REFLECTION

Ask students to write out their rationale for the choices in data sources, and their interpretation of the figured data. Ask students to reason whether their ancestors could gather the type of data they suggested. What could our ancestors notice, and how could they collect that data? If the proverb does not reflect today's experiences, ask students to think about what has happened that might have changed the environment to shift the outcomes. Can the students (re)write proverbs or poems that feel more relevant?

Innovation

Whether by artificial intelligence, scientific breakthroughs, or cutting-edge design, the pursuit to understand and make meaning of our world is connected to our cultures and traditions. Advancements in technology surely are innovative and *new*, yet many times their utility is grounded in ancient concepts of relationality and community. For us, one practical outcome of this is focusing on the vital work of educators innovating learning experiences for their students rooted in their local contexts.

When you build place-based learning experiences for students, you're innovating in a way that honors the fact that knowledge or practices do not need to be separately ancient or modern. For example, a sustainability initiative with the nonprofit coding organization Purple Maiʻa and the University of Hawaiʻi system (Purple Maiʻa, 2020) uses *(k)new* to describe their collective work to support *future ancestors* (Purple Maiʻa, 2024). In their program description, they note, "We believe that the next generation of entrepreneurs need to understand creating value from a community and cultural context. By being in community, their ideas and innovations will be of the community." We also appreciate how Potawatomi botanist and author Robin Wall Kimmerer's best-selling book *Braiding Sweetgrass* (2013) labels her integrated ways of investigating nature through both Indigenous and Western scientific frameworks as "two-eyed seeing." *Etuaptmumk*, the Mi'kmaw word for two-eyed seeing, honors the simultaneity of existing and learning with multiple ways of knowing (Marshall et al., 2015; Peltier, 2018).

(K)NEW INVITATION

Inclusivity

Are there times in your professional or personal life where you have been able to inclusively and simultaneously welcome multiple traditions and viewpoints? Maybe you've planned both Chanukah and Christmas celebrations in your family, held space for complex emotions about current events, or hosted an international visitor? In writing or discussion with a friend, reflect on these experiences; alternatively, or additionally, record any questions you have about this

idea. How might you leverage these experiences to lean into bringing forward (k)new knowledge and practices with your students? If you are looking for a resource to get started, *Braiding Sweetgrass* will further your learning about Native viewpoints of land, nature, and caregiving.

The practice of weaving multiple ways of science opens the conversation to the question, what is "proper" in science learning? Multiple STEM researchers are investigating where science teachers can expand their perceived boundaries of science practices (Götschel, 2019; Gunckel, 2019). By resisting the normed protocols of rote investigation or observation in classroom settings in forty-five-minute chunks, we can invite classroom participants—both teachers and students—to engage in science without socialized presumptions of productivity or rote performance.

To understand the power of (k)new innovations in curriculum, it's important for us to note that school-based science in the United States has a long national history of rigidity over rigor. Over the past two centuries, the standards we use to build and assess science education continue to echo the specific standards developed by academics, economic, and political sectors (Hurd, 1961; Rudolph, 2012). In the 1920s, for example, US science curriculum focused on hygiene, sanitation, and food preparation to support the country's budding industries (Hurd, 1961; Sheppard & Robbins, 2007). From the 1940s to the 1970, however, physics and chemistry enjoyed strong public support due to their crucial roles in World War II and the perceived national crisis that followed, as other countries advanced in scientific and weapons innovation during the Sputnik era (Rudolph, 2012). Because of this focus, and the unequal distribution of funding across disciplines, biology curriculum suffered and was relegated to textbook-standard laboratory investigations with predictable, predetermined outcomes (Rudolph, 2012).

In 1990, the American Association for the Advancement of Science (AAAS) published *Science for All Americans*. This resource stated that most Americans were not science literate, and that on the foundation of democracy and strong leadership, science and technology proficiency should increase in young Americans (Cuban, 1995; Rutherford & Ahlgren, 1991). However, a "science for all" approach

created a common curriculum that devalued individual lived experiences and multicultural competence (Osborne & Calabrese Barton, 2000; Tippins et al., 1999).

In 2012, *A Framework for K–12 Science Education* called for a set of national standards in science education (National Research Council, 2012). The intent was to take fewer concepts and dig deeper, to encourage more comprehensive understanding, which suggested that students may have the opportunity to be successful in later education and their careers (NRC, 2012). Science and engineering practices became increasingly integrated, reinforcing the importance of STEM as a foundational learning framework (Moore et al., 2015), and as of this writing more than 71 percent of US students have science education standards linked to the *Framework* and/or the Next Generation Science Standards (OpenSciEd, n.d.). We think there's lots to love about these standards, but we also want to connect both students and ourselves to how they can be leveraged in place-based learning to create innovative, high-interest, transformative educational experiences.

(K)NEW INVITATION

Histories of Place

Investigate one or more of the histories described earlier in greater detail. Take notes as you explore: What comes up for you? How has your own history of science learning and science teaching been influenced by these events and mindsets?

Belonging for Students

A sense of belonging is the collective foundation for the shared work of trust and respect in the classroom setting. Although belonging is essential for student engagement and growth, it's important to remember that belonging can look different for each student and fluctuate throughout the year. Some students feel immediately connected, while others may need time, support, and encouragement to find their place.

As teachers, we need to remain flexible and responsive, adapting to our students' needs and experiences to ensure all learners are seen, valued, and included in the classroom community.

Learning and Community for All

Research has shown that the standardization of science education has been harmful to colonized and other minoritized groups, leading to detrimental effects on health, career trajectories, and loss of cultural knowledge (Bazzul, 2015; Calabrese Barton & Osborne, 1995; Joftus & Maddox-Dolan, 2003). Contemporary scientific practice has frequently dismissed or devalued Indigenous knowledge systems and reinforced colonial narratives. These legacies unintentionally persist in curricula, classroom practices, and systems, and may alienate students who do not see their cultures, histories, or ways of knowing reflected or respected. By recognizing this harm and addressing it in the learning space, teachers create opportunities for students to find genuine belonging in the classroom.

Building Belonging in Science Class

We want students to see themselves in all facets of science: in science class, in the stories we tell, in the careers of science, and in the practice of doing science every day. This is the sense of belonging that blossoms from our relations with people that we see as scientists, and the people that practice science in school and in the community.

As we've discussed, our identities are also formed through our connections with place (Sobel, 2004). Science identity is the ability for one to develop self-concept as it relates to science performance, persistence, and potential career trajectories (Hazari et al., 2013; Osborne & Walker, 2006). Trujillo and Tanner (2014) recognize that science identity is one of a few strands that impact student learning. The other areas these authors identify are self-efficacy and sense of belonging. However, a great amount of science learning research entangles these concepts, as science identity has been difficult to assess (Trujillo & Tanner, 2014).

All students may benefit from a sense of belonging in science, regardless of current science identity. Hazari and colleagues (2013) found that the intentionality of science education to facilitate inclusivity must extend beyond those who strive to have science careers, and support all individuals to see themselves as science people.

(K)NEW INVITATION

Inventorying the Science Classroom

You are the person who is most familiar with your science classroom: how it looks, how it feels, and how it operates. As a science teacher in a middle or high school, you may teach the same lesson multiple times in the span of a week. Often, our third time teaching a lesson is our best. We are so familiar with the lesson opening questions, the jokes mid-way, and the pain points through our formative assessment of student work. However, we should remember that, whether it's our first or fifth time teaching the lesson, it is often our students' one and only time being in the moment.

Take a step back and inventory your classroom space. Here are some questions that may guide your own inventory reflection.

Physical Space:

- What does your science classroom look like?
- If there are posters, images, or quotes on the wall, is there a diversity of origination? Are the quotes largely by men? Are the humans on the posters largely white-presenting?

Emotional Space:

- What does your science classroom feel like?
- How would you describe the characteristics of a typical successful student in your class?
- What skills or dispositions are valued on your rubrics? Is timeliness or neatness a part of your grading?
- Whose stories do we amplify in the vignettes of science history? Whose stories go untold?

Human Capital:

- Does the science department faculty at your school reflect the student population?
- If guest speakers or career panels are invited into school, do these adults come from the community? Did they graduate from the same or similar school settings? Did they have the same opportunities as your students?

As we continue to practice introspection of our own practices, unconscious and unexpected biases may surface. This is a part of the process. Honoring that we do have societal and systemic biases is a part of our work to ensure that our students see themselves as science learners and doers. If you feel safe to do so, push back on some of the biases that have surfaced. You may find a (k)new practice in science that reflects the brilliance of your students and invites a deeper sense of belonging in class and content.

NOTES

TRY IT!

Ideas for Building Belonging in Science Class

GOAL

To create a science classroom environment where all students feel valued, represented, and empowered to engage in authentic science practices.

DESCRIPTION

1. **Find ways to display student work in which students are authentically engaging in science or engineering practices.**
   - Sometimes, middle and high school teachers forget the sense of pride and respect that students can feel on seeing their own work on display.
2. **Display or reference quotes or discoveries from scientists from a wide variety of backgrounds.**
   - You can tie this to current events, like creating a bulletin board that shows the STEM backgrounds of Olympians and Paralympians; to the seasons, like pulling quotes from diverse STEM professionals supporting a "Forty Days of Peace" practice in honor of Martin Luther King Jr. Day; or where you live, like adding a once-weekly "local scientist of the week" slide to your agenda that profiles someone from your home city or state.
3. **Build ways for students of all abilities to meaningfully contribute to classroom inquiries.**
   - One of our students, a brilliant young person with an intense stutter, thrived in real-time text chats during student presentations or discussions; another student with mobility limitations found getting classrooms supplies challenging but was second to none when it came to setting up experiments.
4. **Above all, keep learning about how identity shapes how we approach science and learning in general.** See Chapter 4 for more ideas.

ADJUSTMENTS

As you implement these strategies, consider your classroom physical setup, your students' learning profiles, and the cultural context of your school community. Small shifts like making time in class for peer recognition or adjusting the format of participation can make a big impact.

REFLECTION

What did intentionality to build belonging look like before implementing these strategies? What diversity did you notice when actively researching or observing? Where some types of representation harder to find than others?

Science Identity and Belonging

Calabrese Barton and colleagues' (2013) research on identity in middle school girls suggests that actions and relationships that adolescents experience are important stepping stones prior to formation of adulthood identities. It's just one data point in a bigger scholarship making clear that science identity is not just personal, but also politically and socially constructed (Avraamidou, 2020; Wade-Jaimes & Schwartz, 2019).

The idea of science identity stems from determining who exists, belongs, and behaves in science. When we see our relationships represented in curriculum and application, we become more open to the multiple ways science can be defined and how gained knowledge impacts our lived experiences. As we open ourselves to more ways of knowing in science, more of our lived experiences and personal funds of knowledge feel invited into these formalized science spaces.

Acknowledging Land*

Land acknowledgments are an opportunity for students and teachers to undergo a common learning experience to uncover and expand their understanding of their shared place at school. According to the National Museum of the American Indian (n.d.), "Land acknowledgment is a traditional custom that dates back centuries in many Native nations and communities. Today, Land Acknowledgments are used by Native Peoples and non-Natives to recognize Indigenous Peoples who are the original stewards of the lands on which we now live." In practice, they often also focus on practices of stewardship, an important outcome of place-based learning.

Whitney: I was at a recent International Society for Technology Education (ISTE) conference in Denver, Colorado, and experienced a powerful Land Acknowledgment offered by the keynote speaker. Lyla June Johnston, PhD, is an Indigenous musician, author, and community organizer of Diné (Navajo), Tsétsêhéstâhese (Cheyenne) and European lineages. In a space of technology education often removed from physical attachment, her elevation of Indigenous voice and story resonated in an expansive auditorium of educators. Dr. Johnston transitioned from a Land Acknowledgment statement to stories, historical

*We're thankful to be joined in this chapter by tia north, who is a *Kanaka Maoli* (Native Hawaiian) poet and the Director of Diveristy and Inclusion at the University of Oregon Division of Graduate Studies.

knowledge, and futuristic thinking that captivated the audience. We learn so much when these gifts of knowledge are offered in public venues. However, we may not have access to such a gifted individual, and the responsiblity to share about land should not fall solely on the Indigenous community.

Everyone, not just Indigenous people, has access to holding expertise—and everyone who holds expertise takes responsibility for the land and all who dwell on it. While some knowledge is sacred, ancestral, or entrusted to few, a vast well of knowledge is accessible to anyone looking for it. We can think about Land Acknowledgments in our classroom practice as a temporal record of our position and relation to land, exploring ancestral wisdom and Indigenous histories and culture while allowing ourselves an opportunity to learn through writing, connect science learning to the place we live, and think about the past, present, and future of place through a holistic lens.

How Are Land Acknowledgments a Good Opportunity for Exercising Place-Based Science Concepts and Learning?

As science teachers, we aim to connect our students with the phenomena of the natural world. Land Acknowledgments offer a tangible process to practice an integration of interdisciplinary subjects that are founded in geology, weather, geography, biology, and climate science. In Table 1.3, we show how the prompts that students can explore in writing Land Acknowledgments connect to the Place-Based Science Teaching questions, but Land Acknowledgments can also extend to interdisciplinary curricular development with goals in language, rhetoric, and historical knowledge.

Table 1.3 Guiding Land Acknowledgments Through the Four Questions of Place-Based Science Teaching

FOUNDATIONAL QUESTION	PROMPTS TO SUPPORT CREATING LAND ACKNOWLEDGMENTS
Where are you?	• Where is your location right now?

FOUNDATIONAL QUESTION	PROMPTS TO SUPPORT CREATING LAND ACKNOWLEDGMENTS
	• What are the Native names used to describe this location? Are they different from the names currently used by most people? If yes, what are the histories of those common names? • What geographic features are important to defining this palce? • What ecological features are important for this place? What's the biome for this place? Any defining plants or animals?
When are you?	• Who was here before you? • Do they or their descendants still live here? Why or why not? • What was here before you developed a relationship with this place? • How might Native traditions of land stewardship be honored or (dis)honored by what's happened in this place and what's happening today?
Who are you?	• What is your personal relationship to this place? • How did you and your family come to be here? • How do you currently honor and care for this place/land? • Based on your positionality, what future do you envision with this place?
Who are we together?	• What have you observed is the relationship between humans and land here today? • What could happen if we expressed deeper care for this land? • What would it take to accomplish these ideals?

(K)NEW INVITATION

Writing a Land Acknowledgment

This is great practice for students, but we suggest practicing it first as a teacher. You'll find more ideas to guide your explorations in the pages that follow.

1. Write a one- to two-paragraph reflection, using the questions in Table 1.3, that
   a. acknowledges your own positionalities, histories, and desires for action; and
   b. describes the histories, current experiences, and potential futures of the land you occupy.
2. Hold on to your reflections for a few days. Then, revisit your writing when you are ready and reflect on the endeavor:
   - Was it easy to write? Why or why not?
   - Were there areas of discomfort? Name them if yes.
   - Identify areas of vague language or generalization.
   - Are you writing around an area of discomfort or not knowing?
   - Was there anything that you kept returning to again and again in your statement? If yes, why?
   - ***An ask for the future:*** Identify what you do not know. What do you wish to know, and how will you find it? (See Table 1.3 for an example on what knowledge is embedded in a Land Acknowledgment.)
3. After you have engaged in a learning cycle, revisit your Land Acknowledgment and revise, again using the questions here to reflect on the process and your current knowledge.

Table 1.4 includes concept-specific features of Land Acknowledgments to look for that demonstrate students' intimacy with land, water, and air/atmospheric awareness.

Table 1.4 Potential Science Topics and Human Impact to Discuss in a Land Acknowledgment

SCIENCE CONCEPT	EXAMPLES OF RECENT HUMAN *DISRUPTION*	EXAMPLES OF RECENT HUMAN *INNOVATION*
Water sources or watersheds	Water diversion, desertification, urbanization, pollution, runoff	Wetland protection, sustainable irrigation, water conservation efforts
Endemic and endangered species	Loss of biodiversity, loss of habitat, urbanization, increased disease	Pollinator gardens, native plant reintroduction, Weed Wrangles
Migration routes	Seasonal or reproductive disruption	Limiting light pollution, wildlife corridors
Carbon cycling	Increased carbon output, local changes in weather and climate	Runoff limitation, green roofs, urban cooling, urban forestry, composting
Weathering and erosion	Acid rain, soil salinization	Plant-based erosion control, decreased air pollutants/pollution
Natural resources and minerals	Commercial agriculture, exploitation of resources, drilling	Mindful consumption, sustainable agriculture, e-recycling

Sociocultural Features of Helpful Land Acknowledgments

We're going to look next at the Land Acknowledgment presented by Osa Tui, president of the Hawai'i State Teachers Association, in September 2021; running alongside is tia's analysis. This is just one example of a Land Acknowledgment, and it's not specific to science, but we appreciate how it so elegantly highlights important features of these written tributes:

- Helping us learn about the significance of this specific place and/or time
- Sharing history of the Native/First people(s) that live and/or lived in this place
- If appropriate, gently providing a tip that can help others reframe their understandings and behaviors to better support Native/First peoples of this place, as well as their ideas
- Telling us about your own positionality as it pertains to this place

After you review this example, consider going back to the Land Acknowledgment we shared at the beginning of this book; can you find where we tried to do each of these?

I bid you aloha kakahiaka or good morning on this auspicious day—**the 183rd anniversary of the birth of Queen Lili'uokalani**—Hawai'i's last reigning monarch before the kingdom of Hawai'i was overthrown in a coup d'état by wealthy white businesspeople and landowners with the backing of the US government and military. She led the Onipa'a (or Steadfast) Movement with the motto "Hawai'i for Hawaiians" and was later imprisoned for her and her followers' work to restore the monarchy. She eventually signed a formal abdication to ensure the release and commutation of death sentences for her supporters.

Today marks the official start to Hawaiian History Month and I come to you from the ahupua'a, or Hawaiian land subdivision of Moanalua on the island of O'ahu.

Moanalua is generally known for the land that had been set aside for hula and chanting by 17th century O'ahu high chief Kakūhihewa and likely a resting place for Kamehameha the Great's warriors in their conquest of O'ahu after major battles of Nu'uanu and Kahauiki.

The Hawai'i State Teachers Association building that I am in today sits on land near a number of wahi pana, or sacred sites. One of the most sacred is Leilono, literally "Lono's lei," along the upper rim of the Āliamanu crater which was an entrance to Pō or the otherworld.

It was a place said to be the opening for humankind to enter eternal night right in line with the burial hill of Aliamanu. It is said that this place is round, about two feet or more in circumference and through this hole the ghosts of people slipped through to go down to the strata of Papa-ia-Laka.

Through this opening appeared the supernatural branches of the breadfruit tree of Leiwalo. If a ghost lacked an aumakua—a spirit guardian to save him when he climbed on a branch of the western side of the breadfruit tree, the branch withered at once and broke off, thus plunging the ghost down to the pit of darkness. The boundaries of this place, so the ancients said, were these: Papakōlea which was guarded by a plover; Koleana whose guard was a big caterpillar and Napeha, the western boundary which was guarded by a lizard.

While we may refer to those who live in California as Californians or those in Florida as Flordians, never, ever refer to someone who resides in Hawai'i as Hawaiian. That term is reserved exclusively for those who have native Hawaiian blood.

As one who is simply a Hawai'i resident of Samoan and Caucasian descent, I honor native Hawaiians past, present and emerging as we are all called upon to learn and share what we learn about the native history, culture, and contributions that have been suppressed in telling the story of America.

Significance tied to location and time: What event is meaningful to this particular location or time?

History of First/Indigenous people: This is a collective and shared labor that all partake in to correct and share the history of the space. In this Land Acknowledgment, this history is included throughout this section. The length of this can/should change based on one's personal connection and familiarity to the space. For example, my Land Acknowledgment for Panaewa, my home, birthplace, and site of cultural access, is significantly longer than my Land Acknowledgment for Eugene, Oregon, because I have less history held in my memory. My Land Acknowledgment for Eugene will grow as I get to know my new home. What's important is that I've taken the time to learn these details and hold them in my understanding of the place. I do this for every area that I live on because I feel that that is my responsibility as an ʻāina aloha (Native Hawaiian steward of land and natural resources).

Gentle advocacy: Statements that help to guide others toward better actions are often appreciated.

Positionality: As the speaker, share your connection to the land directly. This creates context and ensures we don't fall into troublesome waters where cultural appropriation or overstepping bounds may be criticized. I am a person of Hawaiian descent, and my positionality perhaps affords me some credibility to lead a Land Acknowledgment—but I appreciate when others lead this instead. It shows me the work that they are doing to be respectful of a place I care deeply about. Allyship is a verb that others can and should partake in. Allies relieve pressure on the most underserved or oppressed by helping others learn and grow.

tia: *People are asking a lot of Land Acknowledgments these days—we want them to be and do everything: heal, teach, light, open, recognize, etc. It can feel daunting to even begin because, though accounting for every moment and experience of history is an impossibility, many of us feel the need to do. In these moments of fear or uncertainty, I can see why it's tempting to borrow a statement that's been pre-crafted (by another person or organization). Maybe one risks less in using the reproduced works of others, but I'm sure one gains very little, as well. Feeling unsure about Land Acknowledgments might be signaling a need to inquire and learn about them. I think our students deserve the opportunity to attempt to craft one on their own. The process asks students to hold multiple truths and experiences simultaneously. Though Whitney and I have swum in the same waters and ventured into the same rainforests, our Land Acknowledgments of home are written completely differently. Our positionalities and perspectives—our truths—differ. Sometimes those truths conflict, complicate, or complement each other, but they coexist. It's messy, but that's the human experience. In many ways, I think we as educators are trying to prepare our students for that complicated messiness.*

Whitney: *People's very different experiences and perceptions of land may be rooted in painful personal and societal histories. Writing a Land Acknowledgment may open wounds, often unexpected, on behalf of yourself, others, and even the land.*

Kirstin: *Teachers know that we are supporting students' emotional growth and development alongside growth in our content area. As I've learned from climate education, we must acknowledge uncomfortable feelings and uncertainty when they come up for our students. I've also learned that teachers can help students experience repair and healing through helping them take action. We've provided tips in Chapter 5.*

Land Acknowledgments Are Best as a Process of Learning

Whitney: *To remember the words of tia and my teacher, Manulani Aluli Meyer, "nouns have always been verbs" (Meyer, 2013). The term* Land Acknowledgment *is a noun. But what might it be when we view it as a verb, an action that causes knowledge to bloom from within and around us? To*

write a Land Acknowledgment requires action, feeling, and relationality. Writing about land and water is tied to our relationships with land and water. We must commit to the experience through writing, rewriting, and rewriting again. I find (k)new concepts each time I revisit the practice, and the practice continues to live within me as I intentionally acknowledge the land where I reside, where I play, and even where I visit.

tia: *If we treat land acknowledgments as static objects without breath, how can they fulfill such lofty aspirations as healing or recognizing or teaching? Putting ourselves into the writing might be the only way in which to bridge this gap. This is also reminding me that Land Acknowledgments offer students the opportunity to gain some comfort in failing. There are so few areas in education where failure seems safe. It's contributed to a host of new challenges for our students, including a perfectionist mindset. I want my students to accept that humans make mistakes—that this should be the base assumption we make of each other. What matters is how we recover and persist through these failures. I've yet to work with a person who views their Land Acknowledgment as perfect. They are continuously finding areas where they want to expand their knowledge or improve the way in which their language is capturing it. Remembering that writing is an iterative process that can and should change as our awareness and knowledge evolves helps us to persist. Accepting that we'll fail and need to return to the work, continuing to deepen our understanding of our positionality and relationality, and holding our expertise ensures our Land Acknowledgments are intentional, authentic, and aware.*

Kirstin: *I remember that my early efforts at Land Acknowledgment accidentally gave the impression that Indigenous people are no longer caretaking the land, erasing the important care that Native peoples with ties to the Midwest are collectively working to further important future-facing causes, including habitat protection. When I rewrote the acknowledgment to account for this misconception, I remember feeling embarrassed but also proud that I had been brave enough to learn and revise my understandings. I love that writing Land Acknowledgments helps us learn more, follow our curiosity, and engage deeply with a place and its caretakers.*

E luʻu hou i ka wai

E luʻu hou i ka wai—dive into the water. Practicing place-based teaching takes immersion of the body, mind, and spirit. Place-based science teaching is a practice of experiencing and observing joy in our everyday phenomena. This work creates high-quality science education, deepening the rigor of learning through the teachings of place and people. Equally important, it builds connection, peacefulness, reflection, and transformative action.

STORIES ACROSS OUR PLACES

Metaphors of the Classroom

Whitney: *In my experience, the emergence of simultaneity within the relationships in and straddling our classroom space presents itself like the unraveling of* hōʻiʻo *(fiddlefern) shoots from a backyard patch. In Japanese, we call these fiddleferns* warabi. *We boil them, and eat the stems in salads and main dishes. While this vegetable grows wild in our town, it is a rare find in grocery stores and farmers' markets elsewhere in the islands. Traditionally, Asian cuisine calls for cooking the ferns, while Hawaiians eat them raw.*

Behind my house, there is a dense patch of hōʻiʻo, *standing tall and in community. If I were to grab a handful, the girth of the fiddleferns are mostly uniform and vertically rigid. Bringing them into the kitchen and tossing cut pieces into boiling water, the rigid* hōʻiʻo *stems start to flex and curl. The fronds loosen, and the fiddleheads open to show their shoots that were once held tightly in a coil. While the boiling water opened the shoots for me to see, I know that the shoots were always there, just held close.*

As a classroom teacher and researcher, I start each school year by looking across my classes and seeing the uniformity of students as a patch of hōʻiʻo. *A little variation, but mainly a collective of students around the same age and sharing a demographic with our larger community. Their pre-post course experiential surveys demonstrate general trends of students acknowledging the shift in their understanding and leveraging of biology as applicable in their lives.*

However, it's the one-on-one student conversations that mirror the process of boiling hōʻiʻo *stems. As our teacher-student relationship "cooks" over the year, each* hōʻiʻo *shoot loosens and opens a vantage point for me to see*

(Continued)

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more of the relationships that each student held closely and dearly. These relationships are not dependent on their experiences in class, rather their visibility is impacted by the opportunities to share these relationships in class. When talking with students and reviewing their classwork, I recognize the multiple relationships that we carry as members within our classroom space, and that which we carry as members of our families and larger communities. Classwork that directly asks students to reflect and explain how their lived experiences inform their decisions demonstrates inclusivity of relationships as factors in our basis of sustainability and compassion.

Kirstin: *I've lived in my place for fifteen years, and my own young children go to school just down the street from the high school where I teach. I, too, am learning to hold the multiple relationships that my students and I carry and share. I am my students' teacher, and I may also be their Girl Scout leader, their martial arts classmate, their Science Olympiad coach, their friends' parent, and/or their parents' friend. In the same way, we can begin to uncover the rich relationships we hold with science and place—as academic discipline(s), as way(s) of knowing, and as an essential component of our current and future well-being.*

REFLECTION QUESTIONS

1. Think about how the definition of place-based teaching applies to where you live. Does this idea of centering place in science teaching resonate with you? Why?
2. Why do you think self-awareness is important when practicing place-based teaching?
3. Compare and contrast **place**-based teaching and **project**-based teaching. What components of each do you feel most comfortable teaching at this moment?
4. What (k)new innovations and invitations are happening in your community, state, or region right now? How might you and your students tap into these movements?
5. Based on what you know so far, what is most interesting to you about place-based teaching? What do you hope to learn in the coming chapters?