WHAT YOUR COLLEAGUES ARE SAYING . . .

Young Scientists in Action is a timely and necessary book that challenges science educators to reimagine science teaching through the lens of social justice. It offers practical strategies to empower students to recognize, critique, and act on societal inequities by using science as a powerful tool for change. I highly recommend this book to every science educator and every leader committed to transforming science education into a force for equity, justice, and community empowerment

Kristopher J. Childs
CEO, The Mathematics Group
Winter Garden, FL

Young Scientists in Action is a practical guide for elementary educators striving to make science meaningful, equitable, and action-oriented. Moldavan and Nafziger offer a powerful framework and ready-to-use lessons that center student voice, critical thinking, and real-world relevance. This book supports teachers in creating classrooms where all students see themselves as scientists and change agents, capable of understanding and improving the world around them.

Stephanie Westhafer
Elementary Representative, Georgia Science Teachers Association
Braselton, GA

This book provides a resource I wish I had as a practicing teacher. Children are naturally curious about science, fairness, and their world, so connecting science and justice-centered teaching is a great fit. The authors provide key information about facilitating these connections and positioning learners to use their science knowledge to take action in their world.

Jennifer Ward
Associate Professor of Early Childhood and Elementary Mathematics
Kennesaw State University
Canton, GA

I had the opportunity to try a lesson in this book. It was engaging for all my students. I was able to scaffold and extend it to meet the needs of all learners. I appreciated the interdisciplinary elements woven into the lesson and that my students could easily connect the learning to their daily lives.

Karli Gilbertson
Fourth-Grade Teacher, ISD 622
St. Paul, MN

This book is very important for elementary science teachers. *Young Scientists in Action* shows how easily science as a tool for advocacy and for social justice can be brought into the classroom with young learners. I can't wait to bring the Elicit-Investigate-Interrogate-Act Framework for Social Justice Lessons format into my elementary science methods classroom.

Katie Brkich
Professor, Georgia Southern University
Statesboro, GA

In this relevant and timely book, the content and resources inspire teachers and administrators in engaging young students to tackle culturally relevant issues at early ages, which is critical in developing scientific literacy. Highly recommended!

Edralin Pagarigan
Resource Teacher, Adjunct Faculty,
Baltimore County Public Schools,
University of Maryland Baltimore County
Rosedale, MD

This book powerfully emphasizes the dual importance of fostering critical thinking and scientific knowledge. The "mirrors, windows, and sliding glass doors" metaphor brilliantly connects social justice to education, highlighting equity in science classrooms. It's an essential read for educators committed to inclusive, reflective, and transformative teaching practices.

Kimberly Morton
Content Specialist, Science & Social Studies K–12
Gilbert, AZ

Young Scientists in Action: Building Critical Thinkers for a Better World just makes sense from a mathematics and STEM education perspective, while leveraging creativity for active and engaged learning. The authors have built a strong framework for supporting the fundamental development of critical thinkers through an approachable and logical organization of complex ideas.

Robert Capraro
Professor Emeritus & Director Emeritus Aggie
STEM Center & Texas A&M University
College Station, TX

As a mathematics educator and STEM educator who has worked extensively with teachers and students, the development of critical thinking is a cornerstone for success in each STEM discipline. This book takes a fresh look at critical thinking, which situates learning from the perspective of investigation and scientific inquiry, as an important motivational factor in becoming an engaged and thoughtful thinker that transcends disciplines.

Mary Margaret Capraro
Professor Emerita & Director Emerita Aggie,
STEM Center & Texas A&M University
College Station, TX

Young Scientists in Action

Dedication

To Myla and Abby, our young scientists, whose curiosity, questions, and wonder remind us why this work matters. May you always explore boldly, think critically, and use your voices to build a better world.

Young Scientists in Action

Building Critical Thinkers for a Better World

Alesia Mickle Moldavan

Bailey Nafziger

CORWIN

CORWIN

FOR INFORMATION:

Corwin
A Sage Company
2455 Teller Road
Thousand Oaks, California 91320
(800) 233-9936
www.corwin.com

Sage Publications Ltd.
1 Oliver's Yard
55 City Road
London EC1Y 1SP
United Kingdom

Sage Publications India Pvt. Ltd.
10th Floor, Emaar Capital Tower 2
MG Road, Sikanderpur
Sector 26, Gurugram
Haryana - 122002
India

Sage Publications Asia-Pacific Pte. Ltd.
18 Cross Street #10-10/11/12
China Square Central
Singapore 048423

Printed in the United States of America

Library of Congress Control Number:

Paperback ISBN: 9781071976449

LCCN: 2025032361

Notice icon by Istock.com/Jobalou

Wonder icon by Istock.com/Dimitris66

This book is printed on acid-free paper.

Vice President and Editorial Director: Monica Eckman
Senior Acquisitions Editor: Debbie Hardin
Senior Editorial Assistant: Nyle DeLeon
Production Editor: Aparajita Srivastava
Typesetter: C&M Digitals (P) Ltd.
Proofreader: Lawrence W. Baker
Indexer: Integra
Cover Designer: Candice Harman

26 27 28 29 30 10 9 8 7 6 5 4 3 2 1

Table of Contents

Foreword

Edna Tan and Angela Calabrese Barton

Elementary school students may not pick up data reports to compare pollution trends across varying geographical locations, but they can undoubtedly make observations in their daily lives and note differences that might not be fair. Can you hear a major roadway from your school's playground? Not all schools can. Can you find shade at a local park? Not all people can.

—Alesia Mickle Moldavan and Bailey Nafziger (2026, p. 28)

A marker of working toward rightful presence is the overall enlargement of who, what, where, when, and for whom that [elementary] school science involves.

—Edna Tan and Angela Calabrese Barton (2023, p. 123)

Young Scientists in Action: Building Critical Thinkers for a Better World lays out accessible on-ramps for elementary school teachers to try out, adapt, and plan standards-aligned, student- and community-focused science lessons rooted in social justice. Drawing from their personal and professional experiences in elementary education, Alesia Mickle Moldavan and Bailey Nafziger delve into three interwoven elements of teaching elementary science in the United States:

1. Young children are inherently curious about the world and deeply value fairness.
2. Science as a discipline has historically been active across cultures with a nature of science that is humanistic and dynamic.
3. Critical scientific literacy is fundamental to empowering and equipping children with the wherewithal to understand and apply scientific content toward more just lives in the here and now, and beyond the walls of the classroom.

Moldavan and Nafziger urge us to teach science toward the all-encompassing wellness of children's whole lives.

In our own work (Calabrese Barton & Tan, 2019, 2020), we have proposed the Rightful Presence framework for justice-oriented teaching. Rightful Presence pushes beyond inclusionary models of equity to orient toward how legitimate participation involves ongoing disruption and restructuring of the powered dynamics that shape participants' opportunities to engage in community with respect and dignity.

Teaching is, and has always been, a political act. When elementary school science is taught as separate from the livelihood of students, especially those most marginalized by schooling and society, students can be positioned as outsiders. The already-present forms of expertise they bring to science learning can be made *invisible*, thereby, too, making children invisible—denying them a Rightful Presence in their learning community.

Working toward Rightful Presence involves disrupting traditional power dynamics and exclusionary norms, aiming to create justice-centered classrooms where students are positioned not just as learners but also as co-constructors of knowledge and community. Students are Rightfully Present in science not because they are good at it, or interested in it, but because their lives—including their pasts, presents, and futures—actively shape what it means to know, do, and become in science.

A core tenet of the Rightful Presence framework is the necessity of allied political struggle, where the ones with more power work with the ones with less power toward shared, justice-oriented goals. One way such allied political struggles manifest is the collective struggle for the right to reauthor rights.

This book offers insights into how elementary school teachers may teach science toward the Rightful Presence of all children.

For example, Moldavan and Nafziger illustrate this right to reauthor rights in the following ways:

- The right to center elementary students as whole children with rich and diverse experiences in their everyday lives as core to the mission of teaching, rather than "covering standards" as a default teaching philosophy
- The right to reclaim time to teach science in the elementary grades, given the high-stakes testing schooling culture that disproportionately elevates literacy and mathematics
- The right to bring everyday observations, concerns, and joyful experiences as legitimate resources for elementary science teaching and learning
- The right to reframe what counts as "phenomena" worthy of scientific study and what counts as sensemaking in relation to these phenomena

- The right to incorporate action-taking that is meaningful to students and communities as powerful and important in science learning
- The right for teachers to ask for and receive help in pausing to reflect, to consider how social justice and science education are inevitably intertwined, and therefore to recognize the power of teaching and learning science toward children and communities experiencing consequential wellness and more just lives—a more Rightful Presence

Working toward Rightful Presence is a collective, social, cultural, and political endeavor. One key starting point, which cuts across the strategies of this text, is finding new ways of making present the lives of children in the everyday learning and work of science. The authors provide a myriad of approaches for disrupting traditional ways of teaching and learning science—the norm of equity as the inclusion model, opening up who and what matters in science class. While working toward Rightful Presence necessitates taking disruptive actions, the authors provide possibilities for how disruption can happen in the pedagogical everyday—such as teachers leveraging sociocultural and sociopolitical phenomena to ground science or centering a dynamic nature of science that extends beyond Western ways of knowing.

Elementary school teachers are professionals doing one of the most important jobs—shaping and equipping young minds and, in doing so, significantly influencing their trajectories. In the United States, elementary school teachers are also some of the most overworked professionals; they are educators who need to be well versed across disciplines, and they are overwhelmingly white, middle class, and female teaching a student demographic that is increasingly diverse, multicultural, and multilingual.

Moldavan and Nafziger take these important factors into consideration. The authors are disarmingly transparent as they reflect on their own learning journeys as white, cis, female elementary school educators and researchers, as well as on their own sensemaking of who they are as people and as elementary teachers, who their students are, and how and why it matters to care deeply for them with and through science teaching for social justice. After laying bare their *whys*, the authors offer concrete suggestions for *hows*, with attention paid to the demands and constraints of varied elementary school contexts. They offer complete adaptable unit plans that are standards aligned, as well as grab-and-go activities for the more time starved, all rooted in social justice.

Together with the authors, we believe unfailingly in the transformative power of science teaching and learning, the noble profession of elementary teaching, and the brilliance of all children. In a world mired in systemic

injustices, the elementary classroom, a ubiquitous space that almost all children inhabit almost daily, can be one that attends, mends, empowers, and equips all children, especially children who are negotiating the most challenging circumstances in everyday spaces. "Can you hear a major roadway from your school's playground? Not all schools can. Can you find shade at a local park? Not all people can." Moldavan and Nafziger show us how elementary teachers might begin.

Preface

This work began, like so many meaningful things do, as a simple conversation between the authors, Alesia and Bailey, who quickly realized that they shared the same passion for change. Though our paths into the world of science education were different, we found ourselves walking side by side with a shared goal: to support and inspire elementary science teachers to become *change agents* in their classrooms.

Through ongoing conversations, shared lesson ideas, and moments of "Have you ever tried this?" and "What if we did that?" we realized we weren't just colleagues—we were *critical friends*. We pushed each other to think deeply, to examine our own assumptions and biases, and to constantly reflect on our practices. Our hope is that this spirit of reflection and growth spills off the pages of this book and into your hands, helping you to see your own science classroom as a space for both curiosity and courage.

So, where did this seed of writing a book begin? In 2024, we submitted a session proposal for the National Science Teaching Association's national conference in Denver, Colorado. Our session was titled "Unpacking a Science for Social Justice Toolbox," and the word *toolbox* quickly became more than a session title. It became our metaphor and our mission.

You see, a toolbox isn't just one shiny new idea. It's filled with options. Some tools may be well worn from use, while others may be shiny and new, waiting to be put into use. The toolbox holds resources you reach for when you're stuck, when you're building something new, or when you're simply trying to make something stronger. That's what we wanted to create for you: a science for social justice *toolbox*—one that includes lessons, activities, big ideas, and reflective questions you can use to challenge yourself and your students to think critically about the world around us.

Now, here's where it gets real. While planning that session, we were not only cultivating our professional passion; we were also growing tiny humans at home. Amid research articles and lesson plans were bottles and *lots* of diapers. And—wouldn't you know it?—diapers themselves became a powerful starting point for one of our science lessons.

Ever heard of *diaper deserts*? We hadn't either, until we started to notice that in some communities, including those where our students live and work,

access to affordable, high-quality diapers is severely limited. That's a real issue, with real consequences. So, we designed a lesson where we examined the absorbency of various diaper brands at different price points. We had participants inspect diapers up close (yes, really!), make scientific observations, gather data, and then connect these findings to real-world social issues like economic inequality and access to basic care products.

It may sound messy, and it was! But that messiness sparked deep, critical conversations among the teachers in our session—conversations that led to *more* ideas for meaningful, justice-centered science instruction. The diaper lesson wasn't just a quirky activity; it was a seed. And as it turns out, it helped plant another one, too.

In that same session, we met Debbie Hardin, a senior acquisitions editor for Corwin and a powerful advocate for transformative education. She not only recognized the energy in the room and the potential in our approach but also encouraged us to take a bold next step: *write this book*. So, we did.

Now here we are, holding open this metaphorical toolbox for *you*, the passionate, curious, and committed elementary science teacher. We know this work isn't easy and you won't be able to use this framework for every science standard you teach in a year. But just like changing diapers or raising kids, it can be messy. Sometimes it smells. Sometimes you want to hand it off to someone else. But if you stick with it, you get those beautiful, unforgettable moments—the moments when a student *gets it*, or asks a question that makes you stop and think, or sees their own life experience reflected in the science they're learning.

That's the joy we're chasing here. And that's the change we believe (and know) is possible.

We encourage you to use this book not just as a guide but as a conversation starter. You might use this in a professional learning community, in teacher book or study groups, or even in those informal after-school chats at your favorite local spot. Talk with your peers. Ask questions. Try something new. Reflect. Grow.

And remember, just like a child learning to ride a bike, there *will* be bumps, bruises, and skinned knees along the way. But those stumbles are part of the learning journey. They remind us *why* we do this work, and remind us of the need to create classrooms where students don't just learn science but learn to use science to make the world better.

Change begins with you—right there in your classroom, with your students, your stories, and science. The impact you want to see in the world starts with the choices you make and the experiences you create.

Let's open the toolbox and get to work. We're so glad you're here.

—Alesia and Bailey

Acknowledgments

This work is a tribute to the many passionate and dedicated teachers who have inspired us along the way. Your courage to teach with heart, to reflect deeply, and to continually push the boundaries of what science education can be is the very reason this book exists. You are the change agents shaping the next generation of thinkers, problem-solvers, and world-builders. We are grateful to learn from and alongside you.

We owe special thanks to Debbie Hardin, senior acquisitions editor at Corwin, for seeing the spark in our work and giving us the space, encouragement, and support to turn it into something bigger. Your belief in us planted the seed for this project, and your guidance helped it grow.

To our families and friends, thank you for cheering us on and giving us the time and grace to write, reflect, and share our story. Your unwavering love and support made this journey possible.

We also extend our heartfelt gratitude to the reviewers and educators who generously gave feedback on our shared units and grab-and-go lessons. Thank you, Karli Gilbertson, for piloting lessons with your fourth graders and providing valuable feedback. These insights helped shape this book into a practical, thoughtful, and responsive resource for teachers everywhere.

To those in our professional networks who continue to share this work in your classrooms, schools, and communities, thank you. Your commitment to equity, action, and student-centered science helps this work ripple out far beyond these pages.

And finally, to the young scientists who inspire us every single day, you are the reason we do what we do. We encourage you to follow your dreams. Don't be afraid to imagine and use science as a tool to help you achieve those dreams.

With deep appreciation,
Alesia and Bailey

PUBLISHER'S ACKNOWLEDGMENTS

Corwin gratefully acknowledges the contributions of the following reviewers:

Karon Akins
Administrator, Riverside County Office of Education
Redlands, CA

Tamara Daugherty
Third-Grade Teacher, Zellwood Elementary
Orlando, FL

Enya Granados
Life Science Teacher, Clarke Central High School
Athens, GA

Courtney Koestler
Associate Professor
Director, Ohio Center for Equity in Mathematics and Science
Athens, OH

Edralin Pagarigan
Resource Teacher, Adjunct Faculty
Baltimore County Public Schools
University of Maryland Baltimore County
Rosedale, MD

Thomas Roberts
Associate Professor, Bowling Green State University
Waterville, OH

Jennifer Ward
Associate Professor of Early Childhood and Elementary Mathematics
Kennesaw State University
Canton, GA

About the Authors

Alesia Mickle Moldavan, PhD, is an associate professor of elementary mathematics and science education in the College of Education at Georgia Southern University. She received her BSEd in mathematics education at the University of Georgia, her MEd in mathematics education at Georgia State University, and her PhD in teaching and learning in mathematics education at Georgia State University. She specializes in teaching mathematics and science methods courses to both preservice and in-service teachers. With a background that includes teaching in diverse Title I secondary schools in Georgia and facilitating science, technology, engineering, and mathematics (STEM) enrichment programs at the elementary level, Alesia brings a wealth of practical and pedagogical experience to her role. Her teaching cultivates meaningful learning experiences by integrating culturally responsive strategies and preparing teachers to identify students' strengths and areas for growth, nurture positive STEM identities, and become ethical advocates and change agents for all learners.

Her research interests center on equitable and culturally responsive teaching practices, as well as the integration of digital technology in teacher education to enhance accessibility and inclusivity. Rooted in a commitment to social justice, her work examines how systemic inequities affect educational outcomes and explores ways to disrupt inequitable narratives. Her recent scholarship emphasizes the development and implementation of innovative curricula and instructional practices in teacher preparation programs that foster cultural awareness, critically engage with issues of equity, and promote STEM justice-oriented advocacy. By empowering teachers with the tools to recognize and address social injustices in educational settings, her research supports the cultivation of socially conscious teachers who are equipped to enact change within and beyond the classroom.

Bailey Nafziger, EdD, is an assistant professor of elementary science education in the College of Education at Georgia Southern University. She received her BS in elementary education from the College of St. Scholastica in Duluth, Minnesota, her master's in science education from Northern Arizona University, and her educational doctorate from the University of North Dakota.

Bailey spent her first decade in education working as a middle school science teacher and an elementary gifted specialist in southern Arizona. Along with regular teaching responsibilities, Bailey took on teacher-leadership roles including serving as an instructional coach, mentoring new teachers, and leading professional learning communities, as well as designing and facilitating professional development in both science and gifted education at the district and state levels. She also dedicated time to her students by working as a soccer coach, serving as a Student Council advisor, and being an advisor for other various student-led initiatives.

Currently, Bailey teaches elementary science education methods at both the undergraduate and graduate levels. Her classes have a strong theme of asset-based instruction and differentiating to elevate the strengths of each student. Her recent scholarship centers on overlaps between science education, gifted education, and culturally responsive teaching. Her goal is to empower teachers to engage in social justice work in their classrooms while modeling the process to and for their students. Bailey has truly fallen in love with teaching and maintains the goal of preparing teachers for the dedication, passion, and perseverance necessary to succeed in the field today.

Introduction

Science education, at its heart, is about teaching students the methods they'll use to understand the world around them.

—Marilyn Vogel, "Social Justice in Science Class" (2019)

The amount of lesson planning elementary teachers do is extensive—every day, in every subject, and for every student. With reading and mathematics being the most tested subjects, teachers may push science planning and instructional time aside as a form of self-preservation. We get it! You deserve a moment to catch your breath. If you are a teacher who wants to offer more authentic and relevant lessons to your youngest scientists, even with limited time, this book is for you. We aim to support you, as teachers and teacher leaders, to wield science as a force for positive change and ignite passion in your students.

Empowering elementary teachers to create learning environments that foster critical thinking about the broader implications of science is essential. Too often, elementary schools neglect science due to the pressure to prioritize heavily tested skills like reading, writing, and mathematics. This narrow focus can inadvertently overlook science's rich, integrative potential to enhance these skills through inquiry-driven explorations. When given the resources and support to delve into science topics, teachers can help students meaningfully connect scientific concepts to real-world issues, making learning both relevant and purposeful. This approach not only bolsters academic skills across the board but also instills a deeper understanding of how science intersects with and influences various aspects of life.

When science education considers issues pertinent to students' communities, it transforms from a mere academic subject into a powerful tool for social critique and problem-solving. Furthermore, using phenomena-based learning as a catalyst for inquiry lets students see firsthand how they can apply science to address and challenge systems of oppression and injustice in their everyday lives. This approach encourages students to think critically about societal issues and empowers them to use their scientific knowledge to

When science education considers issues pertinent to students' communities, it transforms from a mere academic subject into a powerful tool for social critique and problem-solving.

advocate for change. In addition to fostering critical thinking and analytical skills, teaching science through pedagogical practices rooted in building connections between schools and communities—and, more broadly, the world—cultivates a sense of agency and responsibility in students, which aligns with teaching for social justice. Teachers can use social justice science teaching to equip students with a toolbox to examine social disparities and explore ways they can intervene to seek equity and justice.

As you read and implement the ideas from this book into your classroom, we anticipate that you will see for yourself the benefits of social justice science teaching. These benefits will not only enhance your science teaching but also significantly impact the way your students use science to advocate for themselves and their communities. Specifically, you can expect to do all of the following:

- Gain a deeper understanding of your students, recognizing them as capable science learners and potential social justice advocates.
- See students' diverse assets and experiences as opportunities to amplify their voices and agency within their communities.
- Learn how to connect science to students' lives in meaningful ways through real-world phenomena.
- Ignite students' curiosity and give them the tools to act as scientists and make sense of natural phenomena while improving their science literacy.
- Explore how science can be a tool to address social disparities, empowering students to lead efforts to improve injustices.
- Discover how integrating social justice into your science instruction can advance your professional development and enhance what you are already doing in your classroom.
- Realize that you are not alone in this endeavor and, although the journey may be challenging, it is profoundly rewarding.

WHY THIS BOOK?

> Injustice anywhere is a threat to justice everywhere.
>
> —Martin Luther King Jr.,
> *Letter From a Birmingham Jail* (1963)

Think of justice as a ripple effect and consider how an initial disturbance causes effects that expand outward and influence a broader area. For instance, consider the lack of access to quality science resources and high-quality teachers with the knowledge to teach science at an underfunded school. The lack of funding offered to a school may limit exposure to science activities (during or after school) and the availability of up-to-date curriculum and lab materials to guide student learning opportunities. Students at the school may be less likely to become interested in science and may perform at a lower level than peers

at well-funded schools. This ripple effect can reinforce data noting how students from underfunded schools are less likely to pursue science, technology, engineering, and mathematics (STEM) careers. A community with fewer STEM professionals may face economic disparity and shortages in needed STEM fields like health care and technological advancements that impact the quality of life within a community. Furthermore, the underrepresentation of minoritized communities in STEM perpetuates stereotypes and biases, which influences further opportunities for community members, both current and in the future.

Social justice science teaching explores issues of injustice, such as community underfunding, environmental injustice, representation in science, climate change, and food insecurity, just to name a few, integrated into curricula, even at an elementary level. Teachers can play a vital role in helping students understand and address the inequities that exist in science education and the broader community. Your part in teaching science for social justice is needed not only to help break the ripple effect of disadvantage but also to create a more just and equitable society where students, particularly those who identify as Black, Brown, and Latinx,[1] have opportunities to succeed in science and contribute positively to their communities.

Teachers can play a vital role in helping students understand and address the inequities that exist in science education and the broader community.

So, what is the first step in doing this important work in your classroom? Before we jump in, let us take a step back and take a deep breath. Teaching science for social justice is not easy, nor should it be. You may wonder what topics to introduce and how to connect them to the curriculum effectively. You might also question the developmental and age appropriateness of the topics and how to facilitate meaningful conversations on societal issues from varying perspectives, including those of the privileged and the oppressed. Concerns about student reactions and responses from administrators, families, and community members are valid but should not deter you from incorporating social justice into science education. While there may be challenges and risks in engaging in social justice science teaching, especially at a time

[1]In this book, we intentionally capitalize *Black* and *Brown* while leaving *white* in lowercase. This language choice honors the cultural, historical, and political identities of these communities. Leaving *white* lowercase pushes back on the idea that whiteness is the default or standard. Language can quietly reinforce systems of privilege, and this small shift is one way we can interrupt that. We also use *Latinx* as a gender-inclusive term for people of Latin American descent, recognizing its intention to include all gender identities and challenge the gender binary embedded in the Spanish language. We use it deliberately and with respect. At the same time, we acknowledge that not everyone in the community embraces the term, and conversations around identity and language are ongoing. We remain committed to using language that strives to be inclusive, even as we stay attentive to how these terms continue to evolve.

when both science and social justice are under partisan attack, the work is essential to humanize education and open the doors of access and opportunity for all, particularly those who have suffered and continue to suffer from unjust practices.

It is also important to challenge the common misconception that young students, such as those in elementary school, are unaware of societal issues. In fact, elementary students are often quick to recognize and articulate instances of unfairness. As a teacher, you can harness this innate awareness to help students examine injustice and understand how they can contribute positively as citizens. We wrote this book to share with you the knowledge, skills, and confidence to undertake this important work. By developing this toolbox, so to speak, you can ensure that children are prepared to make a positive impact on their communities and the world. Throughout the book, we provide practical strategies for teaching science for social justice, empowering students to become agents of change. If the journey gets tough, remember what brought you to this book in the first place—a drive to nurture a generation of informed, empathetic, and proactive individuals through social justice science teaching.

And, while you may have personal reasons for doing this work, research supports several reasons why teaching science for social justice benefits both teachers and students. Teaching science for social justice can do all of the following:

1. Promote Critical Thinking: *Teachers* can enhance their teaching strategies by connecting science content to relevant societal issues to promote inquiry and a deeper understanding of scientific concepts. This approach encourages *students* to question and analyze these issues from a scientific lens, fostering critical thinking and problem-solving skills (Vieira & Tenreiro-Vieira, 2016).
2. Enhance Relevance and Engagement: When *teachers* incorporate students' interests and experiences, they create a dynamic and interactive learning environment where lessons and labs are more impactful and engaging. Making science relevant to *students* increases their engagement and motivation to learn (Shin et al., 2019).
3. Develop Respect and Social Awareness: *Teachers* can foster a more inclusive classroom environment that values diversity and equity. In turn, *students* can understand and respect diverse experiences and perspectives, building social awareness and responsibility.
4. Build Community Connections: *Teachers* can enrich science learning by creating opportunities for community partnerships and collaborative projects. *Students* can use this approach to see how science is applied in their communities to benefit all.

5. Prompt Equity in Education: By framing social justice lessons with equitable teaching practices, *teachers* can create opportunities for larger conversations around equity and how transformative action can bring about positive change both in and out of science classrooms. *Students*, in turn, can explore how social disparities limit participation and voice, learning ways to confront and challenge these disparities through science, thereby striving for social justice (Rodriguez & Morrison, 2019).
6. Empower Advocacy and Agency: *Teachers* can guide students to apply their scientific knowledge to real-world issues. Doing so helps *students* become advocates for change and develops their use of science skills to address social injustices.
7. Prepare Students for Future Problem-Solving: *Teachers* can use innovative educational approaches to ensure students become aware of and responsive to societal needs (Calabrese Barton & Tan, 2019). When equipped with these skills, *students* can tackle complex, real-world problems effectively.

Throughout this book, we will explore these benefits in further detail. We will position these key ideas in the literature guiding science education, three-dimensional science instruction, the Next Generation Science Standards (NGSS), and the initiatives led by professional organizations (e.g., National Science Teaching Association) that strive to promote excellence and innovation in science teaching, including the advancement of science and social justice education. Additionally, in this book we'll build on the work of social justice in science education (e.g., Atwater et al., 2013; Barton, 2003; Hansson & Yacoubian, 2020). We'll also highlight research occurring in other disciplines like mathematics (e.g., Bartell et al., 2023; Berry et al., 2020; Gutstein, 2006; Koestler et al., 2023) and reference the Learning for Justice (2022) standards framing conversations about identity, diversity, justice, and action. These guiding works will provide a solid foundation as we pursue social justice through a science education lens.

OUR LENSES AND BELIEFS FRAMING THIS BOOK

This book reflects our lenses and experiences teaching in K–12 classrooms and teacher education. Our lenses reflect white, middle-class women privileged to experience education, particularly science and STEM education, and continue to seek additional education in postsecondary contexts. We acknowledge that having opportunities to access high-quality education and be raised in families and communities that support this access is a privilege. And, while our experiences reflect that privilege, we also bring experiences teaching and supervising teachers in Title I schools that serve diverse students from low-income families, where a high percentage of our students qualified for free or reduced-price lunches. Our schools used Title I funding in

hopes of addressing educational disparities and ensuring students had access to high-quality education; however, the funding initiatives also illuminated the additional supports needed, one of which included offering innovative science curricula that connected to students and their communities and empowered them to seek science as an avenue to disrupt systemic inequities. In the following, we offer a deeper dive into our *whys* for this work and how our partnership gave us the strength to push each other to grow, which includes checking ourselves for blind spots, embracing discomfort, and fighting for students and their communities for whom the system was not built.

My Adaptation and *Why* Motivator: Alesia Mickle Moldavan's Lens

From an early age, I hoped to inspire students as a teacher the same way dedicated teachers inspired me. Growing up in a predominantly white, middle-class neighborhood, I had an expectation to do well in education. This expectation, while family driven, was also supported in my K–12 education. "Onward and upward" and "Raise your hand and participate" rang through my ears every morning as I climbed onto the bus that took me to school from an affluent neighborhood. As I carried my bookbag through the school's halls, I also carried the pressure not to let my family down. This pressure continued in college, being a first-generation college graduate from one side of the family and the first to receive a terminal degree (PhD) on either side.

Another innate pressure that drove my educational pursuit was that of facing education with a chronic illness and the uncertainty that comes with living with a progressive disease that can be camouflaged as an invisible disability. Living with cystic fibrosis (CF) is both a blessing and, well, a blessing. CF is a part of me that makes me unique (a blessing), but it also brings challenges that make me grow stronger (another blessing). The challenges give me insights into a system that was not built for individuals with chronic illnesses to follow their educational dreams, especially given that time works against you and school does not stop when you are absent fighting an infection at home or in the hospital. Without my family and medical support, I would not be where I am today.

I recognize that others do not have this support, which drives me to be the model and cheerleader where I can. I also recognize the privileges of an "invisible disability" and how I can hide my disease and blend in with my surroundings so as not to become seen as a victim, in some instances, to a system where those for whom it was built can continue to flourish and reap the benefits. But even now, I wonder why I disclose this information if I am not hospitalized with an exacerbation, teaching with an IV hidden under my clothes, or fighting an infection with tough antibiotics wreaking havoc on my body. Maybe I am not in these circumstances at the moment, but I never know about tomorrow and the uncertainties and stress that come with that.

When teaching, I saw similar stressors with my students at my Title I magnet high school for science and technology. Some students confided their concerns about being the first Black man or first Latinx woman in their family to do well in mathematics and want to pursue STEM in higher education. Some students did not know when they would eat over a weekend or holiday break, which understandably trumped their concern for how they might finish their trigonometry homework even if I let them borrow one of my classroom calculators. While I could not relate to or even fathom these students' challenges and injustices, I knew being an advocate, whether asked or not, drove my purpose to teach and care for all students in my classroom. Teaching STEM further spurred my drive because of the additional hurdles placed before students in historically marginalized communities who are overlooked or questioned for their pursuits in a space not built for them.

With this book I hope to illuminate the need for students to have access to science and STEM more broadly. I also hope to spark conversations about why injustices exist and how students can explore these injustices, even at an early age. While social justice can be an avenue to generate change and justice for all, it can also be an opportunity for students to self-reflect and see how they can be empowered to confront their life challenges, whatever they may be. With the skills, instructional strategies, and lessons shared in this book, I wish for you to continue to grow into your role as a change agent at your school. Let your difference create a ripple effect in your school and community. Students need strong science teachers who can be their advocates, and I wish to cheer you on since my time in life, and anyone's time in life, is uncertain. So, let us make the difference starting today.

Let your difference create a ripple effect in your school and community.

Looking Back to Move Forward With My *Why*: Bailey Nafziger's Lens

The *whys* for writing this book are the students I had in my first years of teaching. Some of you may hold the same sentiment when reflecting on your first year in the classroom—I just want to apologize to those students! It was not for lack of effort; I worked nights and weekends to plan, grade, and organize class periods and middle school dances. However, I missed the forest for the trees. I did not tune into my students' needs and experiences in the lessons I was planning or the feedback I was providing. Instead, I put my head down and trudged through content without recognizing what my students truly needed from me. *Hint: It was not a lecture on Newton's laws.*

After reflecting, I now know I was not prepared to engage my students *on their terms*. I had the content knowledge and knowledge of "best practices," but it became increasingly clear I was not prepared for *my students and their community*. My students were predominantly Hispanic, and their parents

worked long hours as migrant agricultural workers, which was very different from my hometown community, mostly comprising white, middle-class families in North Dakota. My ability to explain Punnett squares was irrelevant to my students' lives. They tuned out, and my frustration grew. I dedicated my time and energy to forcing my students to fit into my idea of what a classroom *should* look like.

Capitalizing on student and community strengths puts your students in the driver's seat to steer learning while building stronger relationships, communication skills, and empathy for others.

As I continued my education and gained more years in the classroom, I learned and experienced how important and meaningful it is to build a classroom *for the students* rather than building the students for the classroom. Capitalizing on student and community strengths puts your students in the driver's seat to steer learning while building stronger relationships, communication skills, and empathy for others. So, my *why* for this book is somewhat of an apology letter to my first classroom and a hope for teachers to see the value in the communities where they work earlier than I did in my career.

We want you to see value in students' communities, cultural backgrounds, traditions, and linguistic strengths and treat these as assets that they bring to the classroom. Recognizing students' assets in the classroom empowers your students to understand and address societal issues, such as fairness, equity, and human rights. This book strives to help you and your students use science as a tool to develop empathy, critical thinking, and a sense of civic responsibility. Whether you identify as a beginning or veteran teacher, our goal should always be to prepare students for our future world, not just academically but also as compassionate and engaged members of society.

A COLLECTIVE PARTNERSHIP

As mentioned in our *whys*, we are white, cisgender females. We are aware of our privileges and see our individual privileges as motivators for why we developed this book. We took on this challenge in response to our personal teaching philosophies and see alignment in how the book reflects our teacher education program initiatives in our College of Education at Georgia Southern University. We both teach elementary science methods courses and collaboratively plan to develop and refine innovative curricula. In our work, we see diverse preservice and in-service teachers with varying levels of science knowledge and confidence in their abilities to teach and learn science.

As part of a student inventory assessment in our elementary science methods courses administered during the first week of class, we ask preservice and in-service teachers to complete a science autobiography to reflect on their relationship with science as both a learner and a teacher. Most of the time,

preservice and in-service teachers self-report negative views toward science, often due to past experiences where they struggled with content or found science unengaging. While some of these teachers attribute their negative views to science being an afterthought at the end of a school day and being taught through irrelevant worksheets, others note that they did not see science as something they could do because the content was presented through a list of memorized facts and reflected "scientists" who did not look like them. These negative perceptions impact their self-efficacy in teaching science, meaning they often feel less capable and confident in teaching science effectively.

Those with favorable views toward science recall times when they could ask questions, get hands-on with materials, and explore scientific concepts through meaningful connections and student-centered learning approaches. Having these positive experiences helps to reinforce positive attitudes toward learning science. Furthermore, these types of experiences help to shape teachers' self-image as capable science teachers who can be successful in a science methods course and the field of teaching science.

Given how the beliefs of preservice and in-service teachers about science are multifaceted and influenced by a combination of past experiences, self-efficacy, and instructional methods encountered when learning science, we see a need to provide positive, hands-on experiences with science teaching that can help shift beliefs toward more positive and effective approaches. One such approach is exploring science through a lens of social justice. As teacher educators and past K–12 schoolteachers, we use these experiences as the lens and beliefs driving this work. We are grateful for the opportunity to share this work with you and invite you on the journey.

THE BOOK'S AUDIENCE

We wrote this book for teachers and teacher leaders who are stakeholders in high-quality elementary science education. We envision teachers using this book in professional development contexts and professional learning communities. Even if such a structured space is unavailable, we still encourage you to read the book and see how the guided teaching manifesto and reflection questions prompt individual self-reflection. Furthermore, teachers who read this book may be new to social justice or even on a journey to becoming social justice–focused teachers in elementary schools. Teachers may also be seasoned with years of experience teaching science for social justice in their toolbox. Regardless of where you align in your teaching journey, you do not have to be an expert in social justice or science education to engage in this book.

We also see this book designed for those in leadership working to support science instruction in elementary contexts. For instance, instructional coaches, administrators, consultants, and curriculum designers might find

Especially in social justice work, the work of an advocate is never done until there is justice for all. But it takes one to begin the ripple effect in a community, so we hope that is you!

this book beneficial. Moreover, elementary science teacher educators whose preservice and in-service teachers are developing their understanding of social justice science teaching and see value in using the lessons to inform their practice may benefit. Whatever lens you bring to this book, know you are welcomed and encouraged to use the ideas as stepping stones along your journey. Especially in social justice work, the work of an advocate is never done until there is justice for all. But it takes one to begin the ripple effect in a community, so we hope that is you!

THE BOOK'S ORGANIZATION

The book consists of three parts. At the end of this introduction, you will have an opportunity to pause and reflect, assessing how you see yourself as a social justice science teacher through a teaching manifesto. The manifesto provides a chance to assess your growth in skills and confidence in using science for social justice. You will revisit and revise it as you progress through the book and respond to the end-of-chapter discussion questions. These questions coincide with the chapter's summary and encourage open dialogue for sharing in your professional development or professional learning community, if applicable.

Part I (Chapters 1–2) provides an overview of teaching social justice in science education and why exploring social justice in the context of science is important, especially for children in elementary school. Chapter 1 lays the groundwork for what social justice looks like in science and how teaching through a lens of empathy can help students look beyond their needs and tune in with others. The chapter also discusses why representation matters in the classroom and references recent social justice initiatives in science education reform, including connections to the NGSS and the Learning for Justice (2022) Social Justice Standards. Chapter 2 provides a rationale for bringing purpose and justice into the science classroom. It starts by discussing how we do (and don't do) science, what counts as science, and the value of community connections and support when teaching science for social justice. Additionally, the chapter reviews related literature about ways to advocate using science. Readers who need a foundation for social justice science education will be encouraged to review Part I before looking into Part II (Chapters 3–5), which presents considerations for designing and implementing social justice science lessons.

In Part II, Chapter 3 addresses steps to plan for a social justice science lesson. It notes the importance of learning about students and seeing diversity as an asset. Additionally, it discusses ways to establish an inclusive classroom community to support and sustain social justice exploration. We suggest ways to

recognize how diverse voices and perspectives hold value, especially from historically marginalized groups. Classroom norms can be set collaboratively with students to promote respect, active listening, and open dialogue. Students can also ask questions and think critically about social justice issues. The essence of focusing on the foundation of the classroom is to establish a classroom community that values students' experiences, negotiates ethics and morals, and presents opportunities for students to engage in argumentation that builds on evidence-based explanations.

Thereafter, we'll share a framework for social justice science lessons, acknowledging phases that encourage teachers to "elicit," "investigate," "interrogate," and "act." We'll explore discussions pertaining to finding the right phenomena, connecting the phenomena to three-dimensional science learning, and taking action. The lessons are built with reference to phenomena that examine social inequities to promote investigations and debates about fairness and equity. For instance, when considering environmental justice, a phenomenon of interest could be pollution. Making connections between pollution and social justice can open doors to exploring how pollution disproportionately affects marginalized and vulnerable communities. Less affluent communities might live closer to polluting industries or waste disposal sites. These settings frequently experience increased exposure to environmental hazards found in air and water. Connecting the phenomena to three-dimensional science learning in the context of social justice is not easy; thus, we describe ways to hone in on the NGSS content standards and the Learning for Justice (2022) Social Justice Standards in a manner that is responsive to students' learning needs and issues in their communities. We close with manageable steps to meet students where they are as they develop critical consciousness toward social injustice.

Chapter 4 provides three science social justice unit plans. The units are driven by relevant, sociocultural-informed phenomena and explicitly address the three dimensions of high-quality science instruction (i.e., Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts) organized using the Elicit–Investigate–Interrogate–Act framework. Students can connect the topics to related issues in their communities and problem-solve ways to take action. The chapter shares the units as examples of ways to teach using the framework and provides additional notes on ways teachers can differentiate and modify the units for similar use in units already implemented in their contexts.

Chapter 5 provides grab-and-go science social justice lessons. These NGSS-aligned lessons reference short case-based scenarios driven by real-life phenomena of social justice issues to prompt individual or collaborative reflection from students. The chapter concludes with reflection questions to identify critical elements of social justice science lessons. The grab-and-go nature of the lessons offers a sample of what students can do in a smaller context, a stand-alone lesson, or a self-guided learning exploration. The lessons are low tech and quick to set up, providing opportunities for

students to explore as an enrichment or when there is not enough time in a school day to devote to science planning.

Part III (Chapters 6–7) recommends the next steps for looking ahead and taking action. Chapter 6 suggests ways of teaching social justice in today's climate. We know teaching is political and, thus, can be confrontational. So, ensuring teachers strategize ways to do good for their students and community while protecting themselves is imperative. Consider the oxygen masks on a plane. You must place one on yourself before you can help others. While the actions may seem selfish, the intent is to ensure you have the strength to care for those around you. Your students need you, especially a strong you, to be their advocate. Thus, in this chapter we touch on knowing your purpose, priorities, and professional responsibilities. It's important to find your people and know your sphere of influence. You must also curate patience for missteps and pitfalls and, more importantly, hold on to hope.

To close the book, in Chapter 7 we encourage reflection on ways to take action in your context. We'll reflect on the book and your growth in developing strategies to design and implement social justice science lessons. We'll mention ways to sustain your work through reflection and renewal. We also hope that you reflect on all that you have learned in the book as you revisit and revise your teaching manifesto. You can share this artifact within your learning community or keep it on your desk as a reminder to stay focused on your priorities for doing social justice work.

YOUR TEACHING MANIFESTO

Complete the following statements to reflect on your *why* for doing social justice science education work. Recording your responses allows you to communicate your vision, guide your practice, keep yourself accountable, evolve your motivation, and support your professional growth. You may share your teaching manifesto with others or keep it private. We will also encourage you to revisit it as you progress through this book to see how your thinking has transformed and what goals you have met.

My Teaching Manifesto

My *why* for doing social justice science education entails . . .

When promoting teaching science for social justice,

- I will be intentional about . . .

- I will keep the focus on . . .

- I will provide opportunities for . . .

- I will be thoughtful in my lesson planning by . . .

- I will teach . . .

- I promise to . . .

- I will view students as . . .

- I will view the community as . . .

PART I

Using Science to Solve Problems

Where Do We Begin?

CHAPTER 1

Connecting Minds and Hearts Through Critical Thinking and Engagement in Science

Science makes people reach selflessly for truth and objectivity; it teaches people to accept reality, with wonder and admiration, not to mention the deep awe and delight that the natural order of things brings to the true scientist.

—Lise Meitner, 20th-century physicist

Teachers are undeniably busy, and we truly appreciate you taking the time to explore our book! Whether teaching science makes you break out into a cold sweat or it's the highlight of your week, we're thrilled you're here to expand your perspective on how elementary students can use science to benefit their communities.

As educators, we have the unique opportunity to create environments where students collaboratively address issues of fairness, respect, and social responsibility—both in their classrooms and beyond. This book aims to provide practical strategies, thoughtful discussions, and valuable insights to help you foster a classroom atmosphere where every student feels valued and empowered to make a positive impact.

So, before you start thinking about the next stack of papers to grade, let's dive in!

As educators, we have the unique opportunity to create environments where students collaboratively address issues of fairness, respect, and social responsibility.

SOURCE: iStock.com/wundervisuals

BUILDING CRITICAL THINKERS

Think about where you see and use the phrase *critical thinking* at school. It might appear on your classroom bulletin board, in the school's mission statements, on standardized assessment rubrics, and in countless educational frameworks. But what does it *really* mean to nurture critical thinkers in our classrooms, and how often are students *truly* positioned to think critically rather than just complete tasks?

In today's fast-moving, information-rich world, the ability to analyze, evaluate, and synthesize information is not just a skill—it's a necessity. For students, becoming critical thinkers means moving beyond rote memorization and passive learning to actively questioning assumptions, identifying patterns, evaluating evidence, and making informed decisions. It means *how* to think, not just *what* to think. This shift requires intentional instructional design and classroom practices that invite inquiry, encourage debate, and celebrate diverse perspectives. As teachers, we must consistently reflect on how our teaching either supports or stifles these habits of mind.

When posed with the same question—*Where do you see critical thinking at school?*—more than 100 science teachers from around the nation contributed to this word cloud:

From kindergarten through graduate school, critical thinking is a key objective outlined in standards, textbooks, and curriculum expectations. Given its prevalence in our field, it should be safe to assume we all know exactly what it is. Right?

Wrong.

Teachers and researchers have yet to agree on a concrete definition and are left with a "sticky thicket" of literature full of differing definitions and developmental models (Nilson, 2021, p. 15). Table 1.1 is a summary of some of the definitions and developmental trajectories researchers have published. What similarities and differences do you notice?

SOURCE: iStock.com/Ed Williams

TABLE 1.1 Definitions of Critical Thinking

DEFINITIONS OF CRITICAL THINKING	DEVELOPMENTAL MODELS OF CRITICAL THINKING

Brookfield's (2012) Assumption-Based Approach
• Three types of assumptions in five different traditions that occur in three interrelated phases:
  ○ (1) discovering the assumptions, (2) checking the accuracy, and (3) taking informed decisions
	Perry's (1968) Theory of Undergraduate Cognitive Development
	• Four stages:
	  ○ Stage 1 (Dualism) to Stage 4 (Commitment)

(Continued)

(Continued)

DEFINITIONS OF CRITICAL THINKING	DEVELOPMENTAL MODELS OF CRITICAL THINKING
Halpern's (2014) Cognitive Psychology Approach • Six critical thinking skills: ○ (1) verbal reasoning, (2) argument analysis, (3) scientific reasoning, (4) statistical reasoning, (5) decision-making, and (6) problem-solving	Paul and Elder's (2010) Foundation for Critical Thinking • Six stages: ○ Stage 1 (Unreflective Thinker) to Stage 6 (Accomplished Thinkers) • Nine intellectual traits: ○ (1) humility, (2) autonomy, (3) integrity, (4) courage, (5) perseverance, (6) curiosity, (7) empathy, (8) fair-mindedness, and (9) confidence in reason
Facione's (2023) Skills and Dispositions • Eight skills: ○ (1) interpretation, (2) explanation, (3) analysis, (4) inference, (5) evaluation, (6) deduction, (7) induction, and (8) numeracy • Seven dispositions: ○ (1) systematic, (2) inquisitive, (3) judicious, (4) truthseeking, (5) analytical, (6) open-minded, and (7) confident in reasoning	Wolcott's (1999) Steps for Better Thinking • Five stages ○ Stage 0 (Confused Fact-Finder) to Stage 4 (Strategic Revisioner)

SMALL STEPS FOR BIG IMPACT: Define What It Means to Analyze and Evaluate

▶ We often ask students to *analyze* a passage or *evaluate* items, but do they know what that means? What is the process they should follow to *analyze* or *evaluate* something? Poll your students and collaboratively define what those words mean. Students need to be able to understand and speak the vocabulary of critical thinking to be successful.

While there are many perspectives on what critical thinking is and how it develops, certain aspects are widely agreed on by researchers and educators. With numerous studies dedicated to establishing a standardized developmental trajectory, we know that critical thinking can indeed be taught and learned. However, it requires intentional and explicit integration into our objectives, questions, and assessments.

Critical thinking doesn't always come easily or naturally to our students, and that's OK! It can be a real challenge because it asks students to engage in self-regulation and using metacognition to manage one's emotions and thoughts when working with others toward a shared goal. As teachers, we should be ready to step in and gently prompt students to consider alternative perspectives that might contradict their beliefs, biases, and misconceptions. Critical thinking isn't just about skills like analyzing and evaluating; it also depends on personal dispositions, like being curious, open-minded, and willing to be empathetic when seeing things from someone else's perspective.

Critical thinking is an intentional process of analyzing, evaluating, and synthesizing information to make reasoned decisions, solve complex problems, and engage thoughtfully with diverse perspectives. It involves questioning assumptions, using evidence, and applying logic in ways that are active, reflective, and contextually responsive.

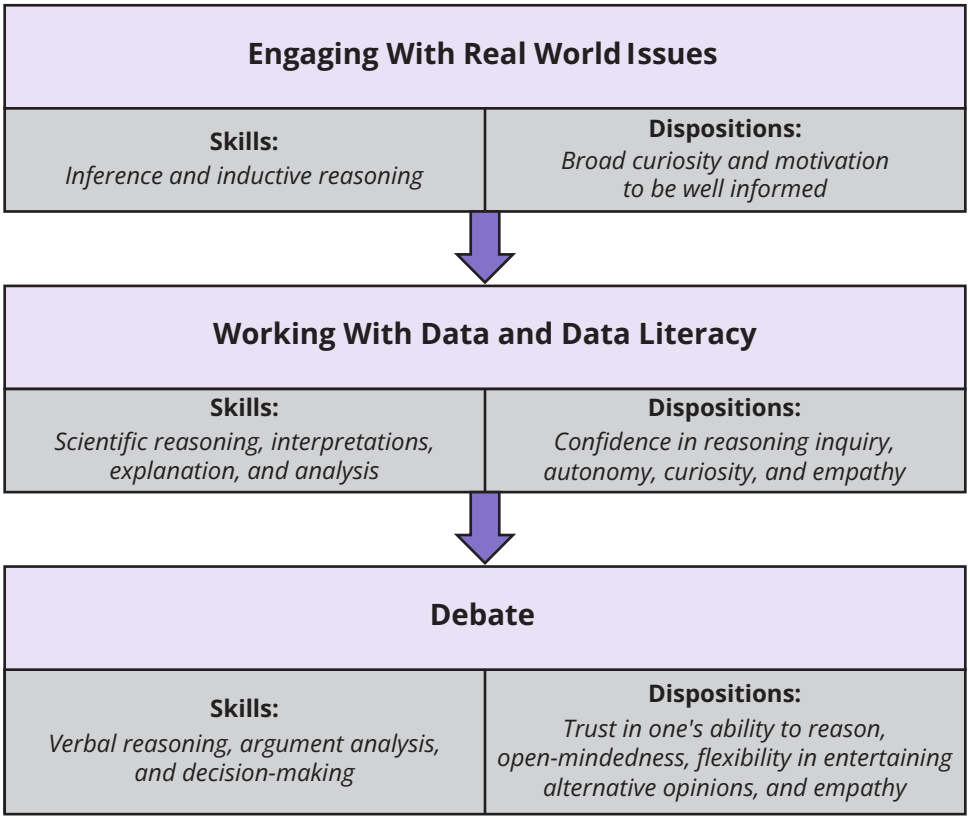
As teachers, we should be ready to step in and gently prompt students to consider alternative perspectives that might contradict their beliefs, biases, and misconceptions.

Throughout this book, we center the teaching of science on critical thinking because developing thoughtful, informed learners is just as important as building scientific knowledge. The activities in both the units (Chapter 4) and the grab-and-go lessons (Chapter 5) follow a consistent structure designed to give your students explicit practice with critical thinking. Each lesson begins with a phenomenon to spark curiosity, followed by opportunities to explore primary or secondary data, and includes structured ways for students to engage in discussion, argumentation, and reflection. These components work together to build the cognitive skills and dispositions necessary for critical thinkers (see Figure 1.1). Better yet, students will practice these skills as they explore complex, real-world problems—learning to think deeply and act responsibly in ways that can create a better world.

EMPATHY IN SCIENCE

One of the intellectual traits of a critical thinker identified by Paul and Elder (2010) is *intellectual empathy*. At first glance, this might seem like an unusual fit for science lessons. After all, empathy is often associated with personal emotions and human connection, while science is traditionally viewed as objective and impersonal, focused on facts, data, and universal truths. Empathetic individuals build relationships, seek to understand other's perspectives, and engage emotionally. Scientists, on the other hand, are often (mis)portrayed as detached, overly rational, and indifferent to social or emotional concerns. These stereotypes, reinforced by popular media, have shaped how the public tends to view scientific work and those who pursue it.

FIGURE 1.1 Purposeful Integration of Critical Thinking in Our Units and Lessons



However, at its core, science is a *human endeavor* driven by curiosity, creativity, collaboration, and, yes, empathy. In this book, we emphasize the importance of recognizing that human traits, including empathy, are not separate from science but integral to how it is practiced and understood. Encouraging intellectual empathy in science classrooms helps students connect with diverse perspectives, appreciate the social dimensions of scientific issues, and engage more thoughtfully in the world around them.

At its core, science is a* human endeavor *driven by curiosity, creativity, collaboration, and, yes, empathy.

SCIENCE AS A HUMAN AND SOCIAL ENDEAVOR

Science thrives on human curiosity, creativity, innovation, and perseverance. These are not optional add-ons to the scientific process; they are the driving forces behind every breakthrough, every discovery, and every question that has ever reshaped how we understand our world. At the heart of every scientific advancement is a person, or a team of people, who followed

their genuine curiosity, asked meaningful questions, and used their creativity to imagine possibilities and design ways to explore them.

Consider the discovery of penicillin. In 1928, Alexander Fleming noticed something unusual: A mold contaminating one of his petri dishes seemed to be killing nearby bacteria. Rather than discarding the petri dish and moving on, he paused, questioned what he was seeing, and pursued a line of inquiry that would eventually revolutionize medicine. Nearly a century later, two high school students in California identified two previously unknown species of scorpion (Jain et al., 2022). These examples, though separated by time, geography, and scale, share a common thread: an insatiable curiosity that's at the very foundation of critical thinking. Asking "Why?" and "What if?" is where science begins. By nurturing these questions in our students, we're not just teaching them facts or formulas. We're helping them develop the key disposition for critical thinkers. In doing so, we position them not only as learners of science but as potential contributors to it.

Asking "Why?" and "What if?" is where science begins. By nurturing these questions in our students, we're not just teaching them facts or formulas. We're helping them develop the key disposition for critical thinkers.

SOURCE: iStock.com/PeopleImages

Science is fundamentally a social endeavor. Discoveries rarely happen in isolation, for they emerge through collaboration, communication, and shared curiosity. Take, for example, Prakrit Jain and Harper Forbes, the teenage scorpion savants mentioned earlier. Their work didn't occur in a vacuum.

Instead, they used the online social platform iNaturalist (www.inaturalist.org) to share their observations and connect with a broader community of scientists and enthusiasts. This virtual collaboration led them to Dr. Lauren Esposito, an arachnologist at the California Academy of Sciences, who joined them in formally studying and documenting the species.

Without collaborative actions, whether through digital platforms, lab teams, or scholarly publication, novel ideas and discoveries cannot be considered scientific facts.

Together, the trio began the lengthy process of publishing their findings in a scientific journal so others would continually reference and build on their novel discovery. Without collaborative actions, whether through digital platforms, lab teams, or scholarly publication, novel ideas and discoveries cannot be considered scientific facts.

SOURCE: iStock.com/Jacob Wackerhausen

Without a healthy balance of empathy, science has the potential to do more harm than good. For example, embedded racism, sexism, and other forms of prejudice have played a role in the development of scientific knowledge. Scientists with biased agendas have cloaked their work in "scientific facts" and engaged in unethical research to advance flawed ideas and beliefs. For example, up until 1972, the U.S. Public Health Service conducted a study on Black men in Tuskegee, Alabama, to observe the natural progression of untreated syphilis. Another example of scientists failing to practice emotional empathy is the case of Henrietta Lacks, whose stem cells, taken in 1951, later became instrumental in medical research. Neither Lacks nor her family received any compensation, credit, or even information on how the immortal HeLa cells led to immeasurable benefits in the fields of cancer research, human genomics, and virology, and even in the development of polio and COVID-19 vaccines (Johns Hopkins Medicine, n.d.). With science being a pathway some

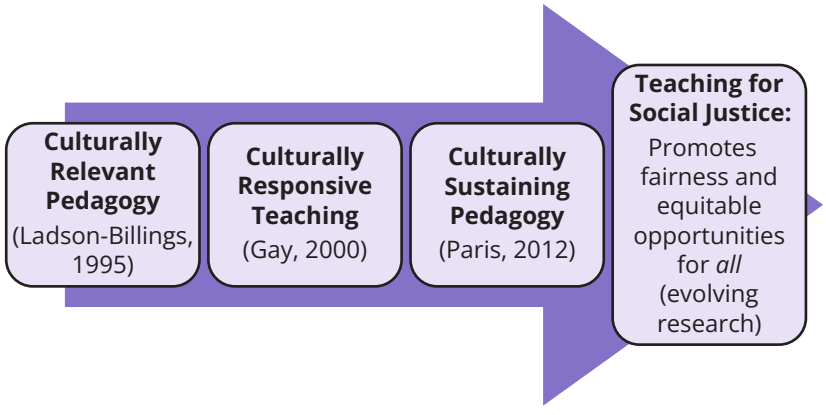
take to capitalize on humanity's strengths or weaknesses, it's important we empower our students with the tools to use science for good and allow them to practice critical thinking and empathy. Their future, and our future, depends on it.

With science being a pathway some take to capitalize on humanity's strengths or weaknesses, it's important we empower our students with the tools to use science for good and allow them to practice critical thinking and empathy.

Tracing Pedagogical Approaches, Illuminating Students' Assets and Communities

If you have completed a teacher preparation program in the past 20 years, you've likely encountered culturally relevant pedagogy. Gloria Ladson-Billings's (1995) work transformed pedagogical thinking by urging teachers to intentionally connect with their students' cultures and experiences, giving voice to those often marginalized. While new terms have emerged since, the pedagogies share a common goal: to leverage students' cultural backgrounds as valuable assets that enrich their learning and promote student success (see Figure 1.2).

FIGURE 1.2 Progression of Culturally Relevant Pedagogy Informing Teaching for Social Justice



When teaching science for social justice, it is important to note that we are building on culturally relevant pedagogy (Ladson-Billings, 1995), culturally responsive teaching (Gay, 2000), and culturally sustaining pedagogy (Paris, 2012) by focusing on *action*. We are asking our students not just to recognize and reflect on social inequalities but to *act* for themselves, their classmates, and their communities to make the world a better place—a tall order for elementary students, you might say. It is. However, elementary students are capable and ready for the challenge. It's up to us, as teachers, to provide the tools and scaffolding.

Remember the child who came to your desk the other day lamenting about something unfair? Your student's issue may have been about something trivial, such as who gets to be the line leader, but it serves as evidence that they are capable and willing to identify inequitable issues. They may also have identified larger issues, such as food disparity or gender stereotypes in mathematics classrooms, but not yet have the words to communicate or take action. Elementary school students are naturally observant and notice issues of fairness and justice around them. These observations are important opportunities for us to notice as fellow teachers to guide students toward empathy, fairness, and a deeper understanding of social justice. In this book, we'll discuss the small steps and quick activities you can take in your classroom today to help prepare your students to think critically and use science *and* empathy for good tomorrow.

SMALL STEPS FOR BIG IMPACT: Create a Fairness Inventory

▶ Creating an inclusive and just classroom environment begins with empowering young learners to recognize and address fairness. Even small moments of inequity—such as some classmates always getting to use the newest lab supplies first or certain voices being heard more often during discussions—can serve as powerful entry points for conversations about fairness. By guiding children to observe and articulate these experiences, teachers can help foster a sense of agency and responsibility in their students.

To start, invite students to look around their classroom or school and identify something that doesn't seem fair. Ask probing questions; for example, *Who gets to use certain materials first? How do we decide who leads activities? Are there places where some students feel more welcome than others?* Encourage students to document their observations in ways that feel natural to them, such as drawing pictures, writing sentences, or verbally sharing their thoughts. These reflections can be collected in a classroom "Fairness Inventory" or displayed on a shared board to revisit over time. By gathering these insights, you can incorporate students' concerns into your future lessons, demonstrating that small steps toward fairness can create meaningful change in their learning community.

Using Science to Explore Fairness

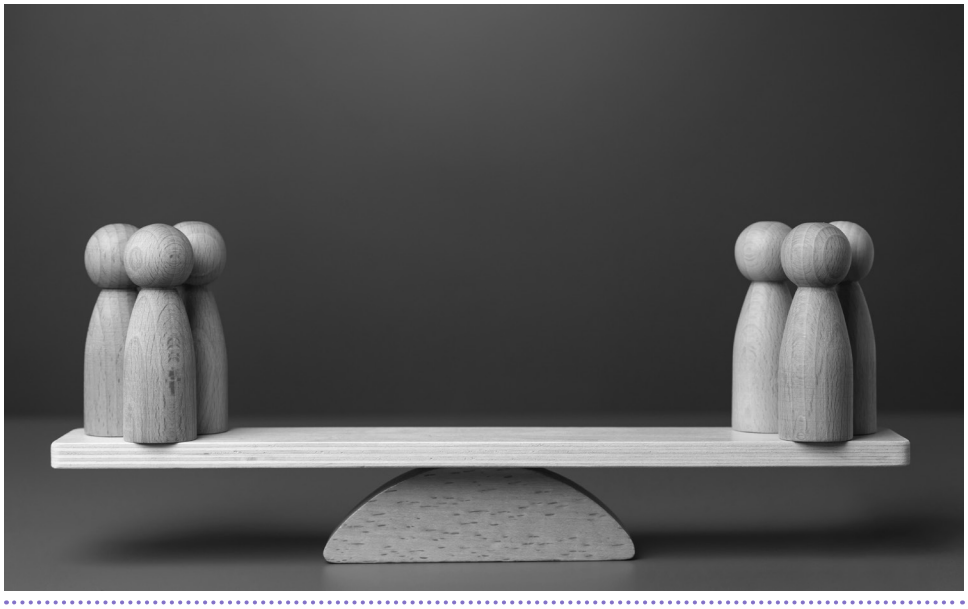
Young children have a strong sense of fairness—they notice when something isn't right and aren't afraid to speak up about it.

Young children have a strong sense of fairness—they notice when something isn't right and aren't afraid to speak up about it. In a science lesson, for example, a teacher might set up an experiment where students observe how plants grow under different conditions. One plant gets plenty of sunlight and water, while another is left in the shade with little care. When students see the struggling plant, it's a perfect opportunity to ask, "What

happens when some people don't have the same resources as others? How does that affect their ability to grow and succeed?" Even young children show an understanding of fairness—think about how toddlers react when a friend gets more crackers or when they see someone being left out of a game. These everyday moments remind us that fairness isn't something we have to teach from scratch—it's already there. Our job is to help students connect it to the bigger picture.

At its heart, science is about asking questions and making sense of the world. Social justice works the same way—it's about understanding how society functions, advocating for access and equity, and recognizing that fairness is not about treating everyone the same but about ensuring everyone gets what they need. When we weave science and social justice together in the classroom, especially in elementary science, we give students the tools to think critically, ask tough questions, and become not just better scientists but also more thoughtful, responsible citizens. By nurturing their curiosity, we help them see that learning isn't just about understanding the world—it's about finding ways to make it better.

Social justice works the same way—it's about understanding how society functions, advocating for access and equity, and recognizing that fairness is not about treating everyone the same but about ensuring everyone gets what they need.



SOURCE: iStock.com/Andrii Yalanskyi

One way to think about science and social justice is by considering how scientific discoveries impact different communities, at both local and global levels. For example, consider environmental science and the issue of

pollution. Low-income communities and communities populated largely by people of color often face the brunt of environmental issues like air and water pollution (Valencia et al., 2023). Elementary school students may not pick up data reports to compare pollution trends across varying geographical locations, but they can undoubtedly make observations in their daily lives and note differences that might not be fair. Can you hear a major roadway from your school's playground? Not all schools can. Can you find shade when you are at a local park? Not all people can.

Marginalized communities comprising predominantly people of color within 100 meters of major roadways are exposed to up to 15% more fine particle matter and nitrogen oxide (air pollutants) than white, affluent communities from traffic-related air pollution (Valencia et al., 2023). When children are on the swings, the air can feel thick, making breathing hard, and sometimes it makes them cough. Suppose they visit other playgrounds in different parts of town. They might notice the discrepancies in the cleanliness of the playground, including trash scattered around, strange-tasting water from the fountains, or the hazy sky overhead. These differences in the environmental conditions can stand out, especially when they start to affect how much fun children have or how safe they feel. This kind of pollution, seen through children's eyes, is just one example discussed later in the book. These lessons highlight how students engage with and "do" science, as well as how they can use science to tackle real-world problems.

Empowering students to recognize and critique inequities sets a crucial foundation for their engagement with larger societal issues, fostering both awareness and agency. When students are encouraged to observe and question the world around them, they begin to develop a lens for understanding systemic injustices. The approach allows children to identify inequities and pushes them to envision ways to advocate for change based on their own experiences. By studying real-world issues, such as environmental pollution, students can witness firsthand how science uncovers and explains injustices, especially in marginalized communities.

Empowering students to recognize and critique inequities sets a crucial foundation for their engagement with larger societal issues, fostering both awareness and agency.

By deepening students' understanding of the causes and effects of injustices, teachers can foster student empathy for the communities most at risk. Teachers can plant seeds of inquiry to grow students' inspiration to think critically about solutions and recognize their role in bringing these solutions to life. Whether through technology, policy, or community action, students can advocate for justice, both in their local communities and on a broader scale. Empowering students to connect science with social awareness cultivates a generation of critical thinkers who see themselves as active participants capable of solving real-world challenges.

SOURCE: iStock.com/Muhammad Labib Adilah

SMALL STEPS FOR BIG IMPACT: Establish a Classroom Care Council

▶ One simple yet powerful way to foster agency in young children is through a "Classroom Care Council." This can start as a weekly discussion where students identify something in their environment that could be improved—perhaps the classroom supplies aren't shared equally, or a quiet student isn't getting a turn to lead an activity. After identifying an issue, guide students in brainstorming solutions. Maybe they will decide to create a sign-up system for shared materials or a buddy system to ensure everyone gets a turn. Small actions like these help children see that their voices matter and that they have the power to make changes, even in their own classroom. By modeling this process and celebrating their efforts, teachers help children develop the confidence and problem-solving skills they need to take meaningful action beyond the classroom.

Understanding Our World and Each Other

As a way to empower students to connect science to their own lives, we want to discover how our students imagine scientists. But first, let's take a moment to reflect on our own perceptions. In the space provided, take two minutes to jot down the names of any scientists that come to mind. Don't overthink it—just write. Once you have your list, consider the following questions to guide your reflection.

Reflect

1. What do you notice about the scientists you listed?
2. Are there any patterns related to gender or race among the scientists you thought of?
3. Did you mention any of your students as scientists? If not, why do you think that is?
4. How do these patterns reflect broader societal ideas of who "gets to" be a scientist?
5. How can we expand our view of what a scientist looks like, and how might that influence the way we teach science in our classrooms?

REPRESENTATION MATTERS

Use your reflections as a powerful entry point to introduce more diverse representations of scientists in your classrooms, which will help your students see themselves as active members of the scientific community. While it is true that largely white, Western men have historically shaped the historical image of science (at least in North America), it is essential to recognize the systems that have privileged certain voices while marginalizing (and obscuring) others. At its core, science is about curiosity, discovery, and making sense of the world. It is a humanized practice, driven by the experiences, observations, and cultures of people from all walks of life.

We must proactively challenge our own and our students' perceptions of who gets to do science.

We must proactively challenge our own and our students' perceptions of who gets to *do science*. Integrating social justice into science education is one approach. Students need to see that science is not just for one group of people or defined by one set of ideas. In Chapter 2, we will dive deeper into this idea of who gets to participate in science. So often, what we teach in schools focuses on Westernized views of science, but a whole world of knowledge exists outside of that lens. Encouraging students to explore different perspectives creates more inclusive and meaningful learning experiences. It also invites students to see that *anyone* can contribute to science, not just those in a white lab coat. When students recognize that science is diverse and is shaped by many cultures, they can begin to appreciate how valuable their ideas and backgrounds are in scientific spaces, making science more accessible and relevant to them. This broadening of what "counts" as science encourages deeper conversations and more flexible mindsets, where many voices can be heard, respected, and valued.

SOURCE: iStock.com/zeljkosantrac

Mirrors, Windows, and Sliding Glass Doors

So, how can teachers deepen students' understanding of the importance of diverse representation in science? We can draw on Bishop's (1990) concept of "mirrors, windows, and sliding glass doors" to ensure students have varied learning experiences that challenge them to reflect on their scientific identities. Bishop's metaphor helps us critique how the stories and perspectives we present in the classroom either reflect students' own experiences (mirrors), provide glimpses into the lives of others (windows), or allow them to step into new worlds and experiences (sliding glass doors). Applying these concepts in science education helps students see themselves and others within the scientific community.

SOURCE: iStock.com/supersizer

When we provide scientific "mirrors," we offer students, especially those from marginalized groups, the opportunity to see themselves as scientists, something they may not have traditionally encountered in science curricula. These mirrors help students connect

their personal experiences and cultural backgrounds to science, reinforcing the idea that their ways of knowing and understanding the world have a place in the scientific community. For example, a Hispanic student learning about Ellen Ochoa, the first Hispanic woman astronaut (NASA, 2023), might recognize their own potential and cultural heritage in a field they previously thought was out of reach—or just never considered.

SOURCE: iStock.com/brizmaker

At the same time, students need access to "windows" into the diverse lives and perspectives of others. Science is a global practice shaped by people from all walks of life. By introducing students to scientists from different backgrounds, such as Indigenous scientists like Dr. Robin Wall Kimmerer (2020), teachers open windows that allow students to learn about alternative methods of approaching and solving problems. These windows offer students the chance to appreciate that science is better because of the diversity of experiences and viewpoints people bring. For instance, studying Indigenous ecological knowledge can give students new perspectives on sustainability and conservation, broadening their understanding of environmental science and environmental appreciation.

Finally, "sliding glass doors" allow students to step into new perspectives and experiences, expanding their sense of what is possible for themselves and the world. When students engage with stories of scientists who have overcome barriers, challenged the status quo, and made groundbreaking discoveries, they begin to see science not just as a set of facts but as a field where they, too, can contribute and innovate. Sliding glass doors invite students to imagine themselves walking into the world of science, realizing they have the agency to change the field, just as others have done before them.

SOURCE: iStock.com/ufukvural

By incorporating Bishop's (1990) idea of "mirrors, windows, and sliding glass doors" into science education, teachers can humanize science and create a more inclusive, equitable learning environment. This approach presents

science as a dynamic, human-driven field that belongs to everyone and emphasizes the value of diverse perspectives in scientific inquiry. When students understand that science is shaped by many voices and lived experiences, they are more likely to ask questions, explore new ideas, and actively participate in scientific inquiry. In doing so, they become part of the ongoing story of discovery and innovation. We must value diverse scientific contributions not just to diversify the history of science—but to reshape its future by inspiring the next generation of problem-solvers.

When students understand that science is shaped by many voices and lived experiences, they are more likely to ask questions, explore new ideas, and actively participate in scientific inquiry.

SMALL STEPS FOR BIG IMPACT: Bring Mirrors, Windows, and Sliding Glass Doors Into Your Classroom

▶ You can bring Bishop's (1990) framework into your science classroom by guiding students through intentional reflections and actions connected to real-world issues. Start by choosing a relevant science topic, such as ecosystems, weather patterns, or human impact on the environment, and frame discussions using mirrors, windows, and sliding glass doors. For example, if you're exploring water pollution, begin with mirrors by asking students to reflect on their own experiences: *Have you ever seen litter in a nearby stream or pond? How did it make you feel? Where does the water you drink come from, and how do you use it every day?* Next, provide windows into other communities by sharing a book, video, or news story about places where water pollution affects wildlife and people's health: *How might a polluted river impact the animals and people who rely on it? What do scientists do to help solve these problems?* Finally, create opportunities for sliding glass doors, where students take action based on what they've learned: *What can we do to keep our water clean? Can we organize a school-wide cleanup, design posters to raise awareness, or write letters to community leaders?*

By weaving these prompts into your science lessons, you help students move beyond learning about a topic to actively engaging with it. Mirrors help them connect science to their own lives, windows broaden their perspectives, and sliding glass doors give them an entry point to take meaningful action. Whether it's through classroom discussions, hands-on projects, or small community efforts, these steps empower students to see themselves as scientists and changemakers, reinforcing the idea that learning is not just about understanding the world—it's about shaping it for the better.

Science as a Tool for Advocacy

One of the most impactful ways science connects with social justice is through advocacy. Science gives us the tools to understand problems and develop evidence-based solutions. When students realize that science is not just a collection of facts but a way to solve real-world problems, they start to see its potential to address the issues that matter most to *them* and their communities. Students who learn how to engage in scientific inquiry and critical thinking can advocate for change in their schools, neighborhoods, and beyond. This shifts the focus of learning science from being based on historical facts to being a tool for action in the present—something that can directly improve their lives and the lives of others.

When students realize that science is not just a collection of facts but a way to solve real-world problems, they start to see its potential to address the issues that matter most to* them *and their communities.

For example, students might explore environmental concerns in their community by conducting research that supports healthier, greener spaces. They could gather data on the benefits of planting trees around their school, showing that shaded areas lead to cooler playground temperatures, making recess more comfortable and safer during warmer months. Alternatively, they could test air quality in areas with and without trees and use their findings to advocate for more green spaces in their neighborhoods. In Bailey's teaching career, this type of work led to the school's student council hosting a garage sale to purchase five Fan Tex ash trees, which they planted near the softball fields for shade. Actionable work empowers students, showing them that science can create meaningful change, even on a local level.

SOURCE: iStock.com/InCommunicado

SMALL STEPS FOR BIG IMPACT: Explore Shade Equity

▶ Would you like to try a similar activity? Maybe planting trees isn't an option, but there are plenty of other ways students can make a difference in their school environment—starting with the playground! Encourage your students to investigate how temperature varies in different areas, such as shaded versus nonshaded spots. They can measure playground temperatures at different times of the day and across seasons to see how heat levels change. To take it a step further, have students collect and organize survey results from classmates about how comfortable they feel during recess in different weather conditions. Do they notice a difference when playing in the shade versus direct sunlight?

Once students organize and analyze their data, they can use their findings to advocate for a solution—like installing shade structures. Have them draft a persuasive letter or create a presentation to share with school leaders. Along the way, guide their thinking with questions like these: *Where would shade structures make the biggest impact? How can we show others that adding shade benefits everyone? What's the best way to share our findings with the school community?* By leading students through the process of researching, analyzing, and advocating for change, you're helping them see how small steps—like collecting data and sharing their ideas—can lead to meaningful improvements in their school and beyond.

Science advocacy projects also provide a way to address equity by encouraging students to examine disparities in their communities (there is a reason the trees were planted near the softball fields and not the baseball fields, as there were more spectators and sponsors for baseball). Students might analyze the number of trees or green spaces in different parts of their town and connect those findings to issues of socioeconomic status. They might find wealthier neighborhoods have more parks and shaded areas, while lower-income neighborhoods have fewer. Armed with these data, students can make a compelling case for why their community deserves investment in green spaces, arguing that access to clean air and cool outdoor spaces should not be tied to income levels. In this way, science becomes more than just a tool for understanding the world—it becomes a means to fight inequality and improve the quality of life for all.

Science becomes more than just a tool for understanding the world—it becomes a means to fight inequality and improve the quality of life for all.

Teachers play a critical role in guiding students through these processes. By fostering a classroom environment where students feel empowered to explore issues that matter to them, teachers can help students see how science intersects with justice and equity. Encouraging students to ask questions like "Who benefits from this solution?" or "Whose voices are missing

from this conversation?" can spark critical discussions about how science can highlight inequities and help advocate for underrepresented communities. Students learn that science is not just for answering large, intangible questions but for creating local, positive change.

SOURCE: iStock.com/monkeybusinessimages

Ultimately, when students see how science can be a tool for advocacy, they begin to understand its full potential—not just as a subject they study but as a means of shaping the world. Whether they advocate for safer playgrounds, cleaner air, or healthier food options, they learn that they can use evidence to effect change. This reinforces the idea that science belongs to everyone and that, regardless of their background or identity, they have a role in using science for the greater good. By engaging students in projects that connect scientific inquiry with advocacy, we can inspire a new generation of scientists and leaders who see science as a field of study and a path toward justice and equity.

Connecting science with social justice is not just about teaching facts—we are helping students see the people represented by the facts.

Connecting science with social justice is not just about teaching facts—we are helping students see the people represented by the facts. This approach shows students that science can help make the world a better place. It also shows students that science is not just something that happens in a lab—it is something that happens in their communities and something that they should be a part of. Furthermore, integrating social justice into

science lessons builds critical thinking skills and encourages students to ask deeper questions. It is not just about the "what" or the "how" of science but also the "why" and the "who." Why are certain communities more affected by environmental issues? Who benefits from scientific discoveries? Who might be left out? These are the kinds of questions that will help students grow into thoughtful, informed citizens who understand how to use science for positive change.

SOURCE: iStock.com/Sergey Khakimullin

CONNECTING INITIATIVES IN SCIENCE EDUCATION REFORM AND STANDARDS TO EQUITY

Remember, you are not alone in this endeavor! National associations are advocating for science education that promotes social justice. Both the National Science Teaching Association (NSTA) and the Next Generation Science Standards (NGSS) have increasingly emphasized the need to teach science through a lens of equity. This focus stems from recognizing that access to high-quality science education is not universally available and that teaching for social justice plays a critical role in shaping the opportunities available to all students. When teaching is approached through a social justice lens, it incorporates equitable access by addressing and challenging systemic inequalities and biases within the curriculum. NSTA and NGSS call for educators to use equity and social justice principles when designing curriculum and instruction to create more inclusive learning environments that empower students to engage critically with societal issues and contribute to a more just society (NSTA, 2020).

Equity in the Context of NSTA and NGSS

NSTA emphasizes that "equity is at the heart of science and teaching, and education is a beacon of light for our students" (NSTA, 2020, para. 3). Furthermore, NSTA has written that science teachers have the responsibility to involve culturally diverse students in science, technology, engineering, and mathematics (STEM) fields by using instructional strategies that recognize and respect the cultural differences students bring to the classroom (NSTA, 2000). More recently, NSTA has expanded its commitment beyond equity to focus on social justice, urging teachers to design lessons around real-world scenarios and help students ask critical questions; for example, *Who made these decisions? Who benefits? Who suffers? Whose voices were silenced?* (MacKenzie et al., 2020).

SOURCE: iStock.com/Delmaine Donson

The NGSS place a strong emphasis on the responsibility of teachers to provide equitable educational opportunities for all students, especially those from non-dominant groups. This includes economically disadvantaged students, students from historically marginalized racial and ethnic backgrounds, students with disabilities, students in rural contexts, and English learners. The NGSS (see NGSS Lead States, 2013) also highlight the need for purposeful instructional planning for *all* students regardless of their sexual orientation, placement in alternative education programs, or learning needs (e.g., neurodivergent, gifted and talented). The standards call on teachers to intentionally design learning experiences that ensure equitable participation in science, recognizing the diverse needs and strengths each student brings to the classroom.

NGSS Appendix D, titled "All Standards, All Students," urges teachers to use equity-based practices for students to "develop agency in science" (NGSS Lead States, 2013, p. 366), which aligns with a social justice approach. Teaching for equity and agency means ensuring that all students, regardless of background or ability, have access to high-quality science instruction and the support they need to succeed. It also means recognizing the systemic barriers that have traditionally kept nondominant groups from fully participating in STEM fields and working to dismantle those barriers within the classroom. When science becomes accessible and relevant to students' lives, interests, and communities, it fosters a sense of **agency**, which refers to a student's capacity to act independently and make choices in their learning. Students who develop agency in science are empowered to explore, ask questions, and engage deeply with scientific concepts. Teachers who cultivate agency help students see themselves as active participants in science, capable of contributing to the scientific community and using science to solve problems that matter most to them.

Agency is a student's capacity to act independently and make choices in their learning.

SOURCE: iStock.com/Yutthana Gaetgeaw

Integrating Standards for Fairness and Agency

In addition to the NGSS, there are other standards that support teachers in fostering agency through a social justice lens. One set of standards that we find informative and easy to adapt to different grade bands is the Learning for Justice (2022) Social Justice Standards. The standards, formally known as the Teaching Tolerance Social Justice Standards, were developed by Learning for Justice, a project of the Southern Poverty Law Center that

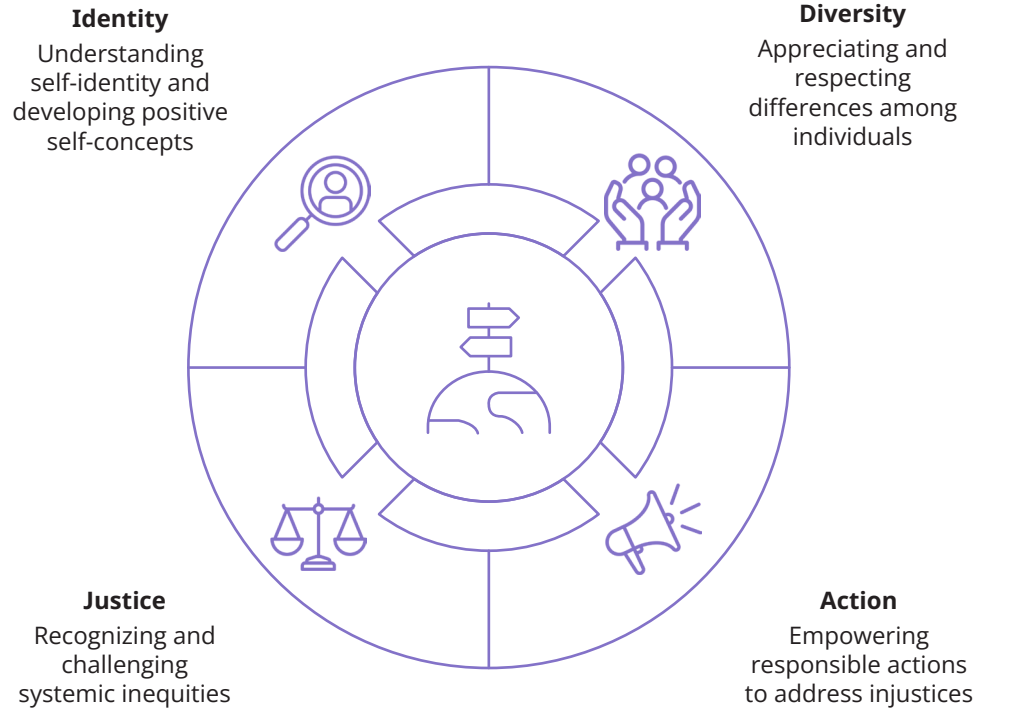
focuses on educational initiatives to promote equity, inclusion, and justice across schools in the United States. The standards were first introduced in 2016 to equip teachers with the tools to create learning environments that challenge prejudice, support diversity, and encourage student engagement in social justice causes. The project was renamed from "Teaching Tolerance" to "Learning for Justice" to recognize that there is more to teaching tolerance, for teachers must actively engage students in the work of equity and justice.

The standards are organized into four domains (see Figure 1.3):

- Identity
- Diversity
- Justice
- Action

Each domain comprises five anchor standards (see Figure 1.4) that help students learn about themselves and others while also empowering them to recognize and challenge bias, oppression, and inequality.

FIGURE 1.3 Four Domains of the Learning for Justice (2022) Social Justice Standards



SOURCE: magnifying glass by Istock.com/myvector, hands icon by Istock.com/FishCoolish, scales icon by Istock.com/Stock Ninja Studios, megaphone icon by Istock.com/Serhii Brvko

FIGURE 1.4 Five Anchor Standards for Each Domain of the Learning for Justice (2022) Social Justice Standards

Social Justice Standards

 Identity	 Diversity	 Justice	 Action
1. Students will develop positive social identities based on their membership in multiple groups in society. 2. Students will develop language and historical and cultural knowledge that affirm and accurately describe their membership in multiple identity groups. 3. Students will recognize that people's multiple identities interact and create unique and complex individuals. 4. Students will express pride, confidence and healthy self-esteem without denying the value and dignity of other people. 5. Students will recognize traits of the dominant culture, their home culture and other cultures and understand how they negotiate their own identity in multiple spaces.	6. Students will express comfort with people who are both similar to and different from them and engage respectfully with all people. 7. Students will develop language and knowledge to accurately and respectfully describe how people (including themselves) are both similar to and different from each other and others in their identity groups. 8. Students will respectfully express curiosity about the history and lived experiences of others and will exchange ideas and beliefs in an open-minded way. 9. Students will respond to diversity by building empathy, respect, understanding and connection. 10. Students will examine diversity in social, cultural, political and historical contexts rather than in ways that are superficial or oversimplified.	11. Students will recognize stereotypes and relate to people as individuals rather than representatives of groups. 12. Students will recognize unfairness on the individual level (e.g., biased speech) and injustice at the institutional or systemic level (e.g., discrimination). 13. Students will analyze the harmful impact of bias and injustice on the world, historically and today. 14. Students will recognize that power and privilege influence relationships on interpersonal, intergroup and institutional levels and consider how they have been affected by those dynamics. 15. Students will identify figures, groups, events and a variety of strategies and philosophies relevant to the history of social justice around the world.	16. Students will express empathy when people are excluded or mistreated because of their identities and concern when they themselves experience bias. 17. Students will recognize their own responsibility to stand up to exclusion, prejudice and injustice. 18. Students will speak up with courage and respect when they or someone else has been hurt or wronged by bias. 19. Students will make principled decisions about when and how to take a stand against bias and injustice in their everyday lives and will do so despite negative peer or group pressure. 20. Students will plan and carry out collective action against bias and injustice in the world and will evaluate what strategies are most effective.

SOURCE: Social Justice Standards (Learning for Justice, 2022, p. 3)

IMAGE SOURCE: magnifying glass by Istock.com/myvector, hands icon by Istock.com/FishCoolish, scales icon by Istock.com/Stock Ninja Studios, megaphone icon by Istock.com/Serhii Brvko

The Social Justice Standards offer teachers a way to weave social justice principles into various disciplines by building on culturally responsive teaching. They emphasize the importance of acknowledging students' identities, assets, and experiences as part of their learning journey. These standards also align with broader movements in antiracist teaching, aiming to dismantle systemic inequities in schools. Teachers can use these standards to create lesson plans, classroom discussions, and even school policies that foster *critical consciousness* and *student agency*. While it might seem like an extra set of learning targets, these standards are not meant to be treated as an add-on to the curriculum. Instead, they serve as a suggested framework for integrating social justice themes into the content you are already teaching. For example, they can guide classroom conversations on identity in science or lead to an exploration of the environmental impact of policies.

SMALL STEPS FOR BIG IMPACT: Foster Agency

Helping students see themselves as scientists starts with recognizing that science is all around them—it's not just something that happens in a lab. A great way to explore their science identity while fostering agency is through a meaningful activity: "Me as a Scientist." Ask students to think about a time when they investigated, explored, or solved a problem in their daily lives. Maybe they experimented with mixing ingredients while cooking, observed insects outside, or figured out why a toy wasn't working. Then, have them draw a picture of themselves as a scientist, showing what they're doing, where they are, and what tools they might be using. For students who prefer writing, they can describe a time they engaged in science, explaining what they did and what they learned. If technology is available, students can even record a short video demonstrating or explaining something science-related they do at home or school. To deepen their critical consciousness, encourage students to also consider how science helps communities solve real-world problems, such as finding ways to reduce waste at school.

As students work, ask guiding questions to help them reflect on their role as scientists and problem-solvers: *What does a scientist look like? Do they have to wear a lab coat, or can they be someone like you? Have you ever asked a question and tested different answers? What happened? What kinds of problems do scientists solve, and what kinds of problems have you solved? How can science help us understand and improve our community?* Prompts like these help students recognize that science isn't just about memorizing facts—it's about curiosity, problem-solving, and taking action to make the world better. Once students finish, create a classroom display or have a share-out session where they present their drawings, writings, or videos. To extend their agency, invite them to brainstorm a small science-based action project to address an issue they care about, such as reducing food waste in the cafeteria. Seeing how their ideas connect to real-world change builds confidence in their ability to use science as a tool for advocacy, helping them recognize that they are not just learners but active contributors to their communities.

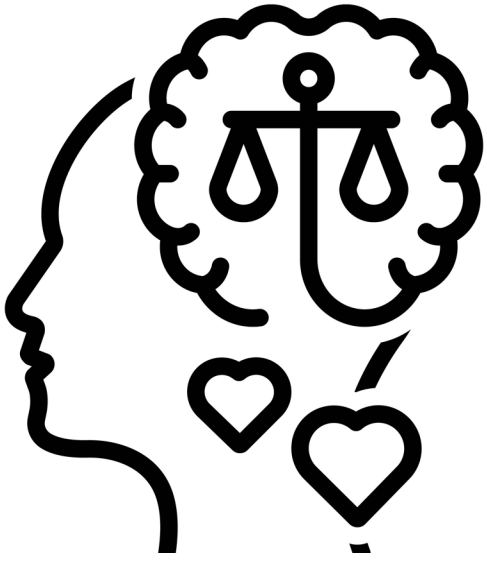
Furthermore, the Learning for Justice (2022) Social Justice Standards are designed for different grade levels, with specific outcomes noted for K–2, 3–5, 6–8, and 9–12, along with example scenarios. For elementary science, they provide a foundation for helping young students learn more about themselves, their community, and the broader world. They help students see science as a tool for understanding and promoting equity and social change. By learning to think critically and engaging in civic activities that use science for the common good, students develop important life skills.

Take the Identity domain, for instance. The standards help students see that anyone can be a scientist, regardless of their background. Teachers can introduce diverse role models from the world of science while encouraging students to explore scientific concepts that directly relate to their lives and communities. This helps students see that science isn't something distant—it is happening all around them and involves people just like them.

The Diversity domain highlights that scientific discovery is a global, multicultural effort that belongs to everyone. By creating collaborative learning opportunities, teachers can show students how different perspectives enhance scientific inquiry. Group projects that involve teamwork teach students that diverse viewpoints can lead to innovative solutions.

Regarding Justice, the standards encourage students to explore environmental or social issues that affect marginalized communities. Students can discuss the ethical implications of scientific advancements, such as who benefits from certain technologies and who might be left out. These conversations help students identify inequities and recognize the importance of working toward fairness.

The Action domain is all about empowering students to use their scientific knowledge for social good. Whether they are advocating for change in their communities or designing projects to tackle real-world problems, students learn how to apply science in meaningful ways. They might explore issues like renewable energy or water conservation and use their knowledge to suggest solutions or raise awareness.



SOURCE: iStock.com/priyanka gupta

Establishing a classroom culture that promotes critical thinking and student agency takes time and thoughtful effort. However, the rewards are immense. By using these standards to guide students in taking ownership of their learning, teachers help cultivate lifelong learners and creative

Science education becomes about acquiring knowledge and developing students' confidence and capacity to make meaningful contributions to their communities and the world.

problem-solvers. These students gain confidence in their ability to experiment, think critically, and work collaboratively with others. In this way, science education becomes about acquiring knowledge and developing students' confidence and capacity to make meaningful contributions to their communities and the world.

CHAPTER SUMMARY

- Integrating social justice into elementary science education fosters critical thinking and empowers students as agents of change.
- Frameworks and resources like the Learning for Justice (2022) Social Justice Standards and NGSS can support teachers in creating learning environments that emphasize equitable, inclusive, and real-world relevance.
- Highlighting diverse role models and fostering collaboration helps students see science as a tool for advocacy and problem-solving.
- Exploring environmental and social justice issues transforms science from an academic subject into a means for civic engagement and social change.
- Teachers play a critical role in student empowerment by creating engaging, safe, and student-driven learning opportunities to grow as learners and leaders.
- Whether you are a first-year or veteran educator, making a commitment to equity in science education benefits students, families, and communities.
- Making science relevant, actionable, and equitable inspires a new generation of thinkers who understand their role in shaping a more just and inclusive world.

REFLECTION QUESTIONS

1. As a student, did you learn science as facts or as a human endeavor? How did that shape your relationship with the field?
2. What scientists do you currently teach in your classroom? Could the list be more diverse?

3. What have you learned about the role empathy has in science?
4. Brainstorm a list of potential issues in your local community that you can use as a teaching moment in your classroom.
5. What steps can you take to ensure all students, especially those from nondominant and underrepresented groups, feel empowered, confident, and excited to dive into scientific inquiry and make their own discoveries?