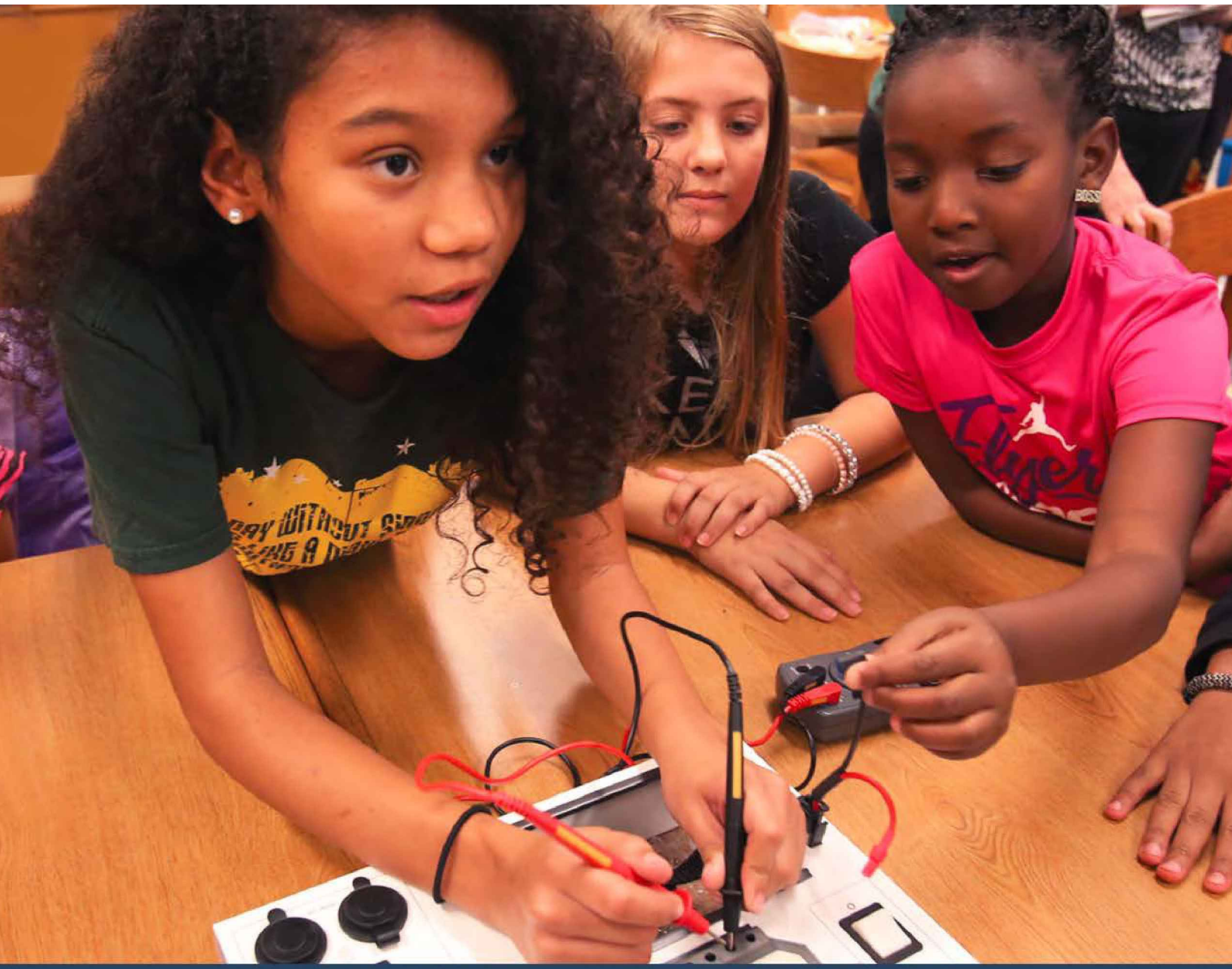

JANICE KOCH

SCIENCE STORIES 6th Edition

Science Methods for Elementary and Middle School Teachers

Sixth Edition

SCIENCE STORIES

Science Methods for Elementary and Middle School Teachers

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***Science Stories: Science Methods for Elementary and Middle School Teachers*, 6th Edition**
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In memory of Beatrice Deutsch

Brief Contents

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Preface

For the elementary or middle school teacher, teaching science is frequently a challenging task, and sometimes it can even be intimidating. This book is an invitation to elementary and middle school science. It is a welcome mat for future teachers, inviting them to the world of science and inspiring them to teach it.

I have written this book so that it can be used as a core text in a science methods course for preservice or in-service teachers. But its approach and content are forged from my own struggles to find material that addresses the school science experience as a natural part of the classroom's daily life. Because many future teachers are apprehensive about teaching science, it is important to help them believe in themselves as science learners and to see themselves as scientific. What does it mean to work like a scientist? Or to think scientifically? Often, like many others in our society, they have a culturally constructed stereotype of the scientist: a kind of mad genius in a white lab coat who does strange, inexplicable things with test tubes. Unfortunately, many conventional texts do little to counter these preconceptions, and when teachers begin to work with students, they often convey the same apprehension and the same brand of stereotype. This book attempts to break the cycle by showing teachers that they do indeed have a "scientist within." By discovering their own scientific selves, teachers can reawaken the joy and wonder of unraveling the mysteries of the natural world, and they can share that experience with their students.

New Features in the Sixth Edition

Since the last edition of *Science Stories* went to press, new national science standards for K–12 science teaching have been developed, offering a three-pronged approach to teaching science. The three dimensions to the Next Generation Science Standards are: (1) science and engineering practices, (2) disciplinary core ideas in life, physical, earth, and space sciences and engineering technology and applications of science, and (3) crosscutting concepts. The first step in developing the new standards was *A Framework for K–12 Science Education* developed by the National Research Council (2012). This document laid out the three dimensions of science education that were the basis for the NGSS (2013). These standards are described and referred to throughout the sixth edition of *Science Stories*. A major goal of sixth edition is to bring these standards to life.

Building on the fifth edition, this edition of *Science Stories* continues to suggest ways to take the students outside and further their understanding and appreciation of nature. At the same time exponential technological growth and an explosion of knowledge in the fields of neuroscience, nanotechnology, and environmental science contribute to the stories in this text. Emphasizing science and engineering practices and not solely science process skills is a major contribution of this sixth edition, while engineering design challenges are a significant feature of *Science Stories*. As our students rely on social media and on their devices for much of their information, there is a flood of data that needs to be vetted. What counts for evidence in making statements about the natural world? What are the data behind global climate change? What can be learned by gathering evidence from events in nature? Watching my own granddaughters grow in this age of instant communication and access to data reminds me that the simple joy of exploring a bird's nest is more important than ever.

The following **new features** are found in this sixth edition:

- New stories of teachers and students working inside and outside the classroom, bringing the STEM education movement to life as they integrate science, technology, engineering, and mathematics.
- Stories that connect literature, poetry, and the visual and performing arts to scientific understandings, adding to the STEAM education movement, where the "A" stands for the arts.
- Included in this edition is an entirely new chapter devoted to science stories of an interdisciplinary nature, integrating scientific understandings with language arts, mathematics, art history, and engineering design.
- This edition continues to emphasize the importance of **engineering design** as a way to apply what students learn in science to the design and construction of models and artifacts. This edition expands on what we know about how people learn. It stresses the importance of **disciplinary core ideas,** what I used to refer to as **"big ideas,"** and how these enduring understandings can be revealed when teachers and students "unpack" those concepts together. It also emphasizes how the science concepts progress to deeper levels as the students mature. Examples of these **learning progressions** are embedded in the text and become explicit in Chapter 7.
- Throughout the book, you will see students accessing the Internet to communicate, gain information, and check for understanding. You will find students actively engaged with social media, online simulations, and blogs set up by their teachers. Yet this edition, like earlier ones, continues to present technology not as an end in itself but as a tool to help students engage in learning projects and construct their own knowledge.
- Chapter 11, "Surrounded by Science: Science Connections across Disciplines," continues to focus on interdisciplinary connections—offering guidance on how to use poetry, literature, social studies, engineering design, and works of art to teach science.

- *The sixth edition of* Science Stories *answers these questions:* How can I do this? Where do I start? How do I use the new standards? What does a successful science lesson look like?
- This edition also contains a comprehensive chapter on life science, physical science, and earth and space science disciplinary core ideas as well as a chapter considering student assessment and, finally, self-assessment.

Chapter-by-Chapter Overview

Chapter 1

In Chapter 1, we introduce the reader to the many ways we can think about science and scientists and to the thinking behind *The Next Generation Science Standards.* This chapter combines the first two chapters from the fifth edition of *Science Stories* and invites the reader to think about their personal experiences with learning science and what steps they may take to becoming invested in their own science learning. Chapter 1 foreshadows the stories of teachers and students doing science together by highlighting what the reader should be looking for. It is here that students are introduced to locating their own inner scientist.

Chapter 2

In this edition, Chapter 2 introduces the reader to what it looks like when teachers and students are engaged in doing science together and expands upon the science stories' meaning by introducing the science concepts and teaching ideas behind each story and how they are connected to the NGSS. Addressing how people learn by constructing meaning from their experiences is key to Chapter 2.

Chapter 3

In Chapter 3 we revisit the science circus from earlier editions, relating the stations to science and engineering practices.

Chapter 4

This chapter takes students outdoors and introduces new stories of doing science with students both inside and outside of the classroom.

Chapter 5

This chapter revisits what it means to get messy in science and how that messiness comes from the investigations and, sometimes, resides in the categories we use to classify matter! In this edition, the reader explores what it would take to teach these messy science lessons themselves. In a new story, third-grade students struggle with how to describe properties of solids, liquids, and gases.

Chapter 6

Extended investigations of living things is a major theme of this chapter, and connections to the NGSS offer insights into the crosscutting concept of structure and function. Living things remain a fascination for all students, especially those in elementary and middle school.

Chapter 7

This chapter brings a learning progression to life as students learn about the mass, volume, and density of materials and different ages and stages of development. We meet the first engineering design challenge of the sixth edition in this chapter.

Chapter 8

In this chapter, we update the former Chapter 9 from the fifth edition. We examine engineering practices in the classroom. A practical part of engineering education, the design challenge asks students to design and construct a solution to a problem using what they have learned about the core concept. This application of knowledge is revealed in Chapter 8 by examining the design and construction of atomic models.

Chapter 9

In this chapter, we problematize the "science kit," reminding the reader that science investigations need to give students the opportunity to plan investigations and argue from evidence. Once again, this sixth edition includes asking the reader questions that will help them find a way to teach this unit themselves.

Chapter 10

Chapter 10 examines basic science content for life, physical, and earth sciences while introducing the reader to the current thinking behind STEM education. This is an excellent lead-in to a more interdisciplinary approach to teaching science that is explored in the new Chapter 11 of the sixth edition.

Chapter 11

Whether it is writing dialog poems, essays, personal letters, or journal entries, writing is a significant part of expressing and communicating science concepts. Some students use artistic devices to express meaning, while others use engineering design or concept maps. This interdisciplinary chapter places science in the center of the elementary and middle school curriculum. The stories are authentic and serve as a reminder that, indeed, we are surrounded by science and that science connections to other disciplines are not hard to find.

Chapter 12

Planning for teaching science is key to a successful lesson. This revised chapter helps the reader to examine what is required to plan and implement a successful K–8 science lesson that is aligned with the NGSS. This edition continues to address the needs of underrepresented groups in science.

Chapter 13

This revised assessment chapter addresses the importance of assessment being a good instructional task and the need for assessment to match instruction. Examples throughout this chapter represent authentic assessment techniques.

Chapter 14

In this final chapter, the emphasis is on metacognition and self-assessment. It offers advice to future teachers as they plan for and implement science investigations throughout elementary and middle school.

Science Stories: Narrative as a Tool for Science Teaching and Learning

Those who are new to this book may wonder, "Why does it tell so many stories?" Thirty years ago, when I began to teach the science methods course at a major metropolitan university, I started telling stories about my own experiences doing science with children. I found that the stories helped my students understand both what science is and how they could facilitate science experiences in their own classrooms.

At about the same time, I was traveling to various school districts to help teachers create science experiences in their classrooms. I spent many months visiting schools and modeling science lessons. As I learned a great deal from the students and their teachers, I realized that their stories had important implications for my teacher education classes. Thus my repertoire of stories naturally expanded. Today, they continue to expand as I work on funded projects to improve science education.

The use of narrative is not new to teacher education, but it is a fresh approach to the science methods course. This book presents much of its theory and its practical advice by way of stories about students and teachers actually doing science together. Rather than imbibing generalities out of context, readers can see what the principles mean in typical classroom situations. This edition connects the NGSS to these stories.

How Do the Science Stories Work?

The stories are set in a framework of discussion that helps readers to see the larger picture. Following each story or set of stories, four sections draw out the implications of the narrative and stimulate reflection.

1. *The Teaching Ideas behind This Story.* A discussion of the science teaching ideas that are demonstrated by the science story. In this section the reader comes to understand the reasoning behind the techniques modeled by the teacher in the story.
2. *The Science Ideas behind This Story.* An explanation of specific science concepts that the reader should understand in order to grasp the science story fully.
3. *Connections to the Next Generation Science Standards.* A description of which NGSS disciplinary core ideas, crosscutting concepts, and science and engineering practices are illustrated.
4. *Exploring Further.* Questions that prepare readers to implement the lessons in their own classrooms.

Other Learning Features of This Text

In addition to the science stories, the vital theoretical background, and the frequent links to national standards, this book provides readers with important tools to help them use the material effectively. These tools include:

- **To Think About.** At the beginning of each chapter, the reader is asked to reflect on a few key questions. These try to make a personal connection to the reader in a way that invites thought about the chapter topics.
- **Marginal Glossary.** The glossary in the margins provides clear, concise definitions of key scientific and pedagogical concepts. The full glossary is provided at the end of the book for a complete listing.
- **Science Concepts.** The Science Concepts box highlights key science concepts, facilitating learning and review.
- **MindTap for Education.** MindTap is a first-of-its kind digital solution with an integrated eportfolio that prepares teachers by providing them with the knowledge, skills, and competencies they must demonstrate to earn an education degree and state licensure and to begin a successful career. Through activities based on real-life teaching situations, MindTap elevates students' thinking by giving them experiences in applying concepts, practicing skills, and evaluating decisions, guiding them to become reflective educators.

Accompanying Teaching and Learning Resources

This sixth edition of *Science Stories* is accompanied by an extensive package of instructor and student resources.

MindTap™: The Personal Learning Experience

MindTap for Koch, *Science Stories*, 6e, represents a new approach to teaching and learning. A highly personalized, fully customizable learning platform with an integrated eportfolio, MindTap helps students to elevate thinking by guiding them to:

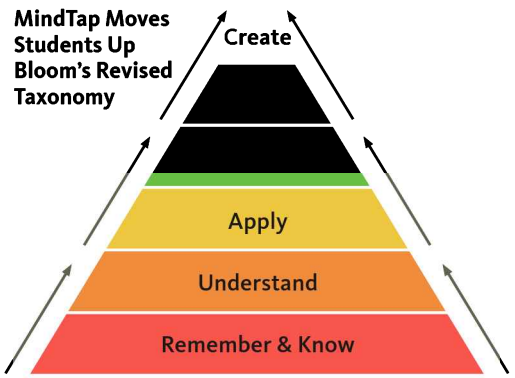
- Know, remember, and understand concepts critical to becoming a great teacher.
- Apply concepts, create curriculum and tools, and demonstrate performance and competency in key areas in the course, including national and state education standards.
- Prepare artifacts for the portfolio and eventual state licensure to launch a successful teaching career.
- Develop the habits to become a reflective practitioner.

As students move through each chapter's Learning Path, they engage in a scaffolded learning experience, designed to move them up Bloom's Taxonomy, from lower- to higher-order thinking skills. The Learning Path enables preservice students to develop these skills and gain confidence by:

- Engaging them with chapter topics and activating their prior knowledge by watching and answering questions about authentic videos of teachers teaching and children learning in real classrooms.
- Checking their comprehension and understanding through Did You Get It? assessments, with varied question types that are autograded for instant feedback.
- Applying concepts through mini-case scenarios—students analyze typical teaching and learning situations, and then create a reasoned response to the issue(s) presented in the scenario.
- Reflecting about and justifying the choices they made within the teaching scenario problem.

MindTap helps instructors facilitate better outcomes by evaluating how future teachers plan and teach lessons in ways that make content clear and help diverse students learn, assessing the effectiveness of their teaching practice, and adjusting teaching as needed. MindTap enables instructors to facilitate better outcomes by:

- Making grades visible in real time through the Student Progress App so students and instructors always have access to current standings in the class.
- Using the Outcome Library to embed national education standards and align them to student learning activities and also allowing instructors to add their state's standards or any other desired outcome.
- Allowing instructors to generate reports on students' performance with the click of a mouse against any standards or outcomes that are in their MindTap course.
- Giving instructors the ability to assess students on state standards or other local outcomes by editing existing or creating their own MindTap activities and then by aligning those activities to any state or other outcomes that the instructor has added to the MindTap Outcome Library.



Anderson, L. W., & Krathwohl, D. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

MindTap for Koch, *Science Stories*, 6e, helps instructors easily set their course since it integrates into the existing Learning Management System and saves instructors time by allowing them to fully customize any aspect of the

learning path. Instructors can change the order of the student learning activities, hide activities they don't want for the course, and—most importantly—create custom assessments and add any standards, outcomes, or content they do want (e.g., YouTube videos, Google docs). Learn more at www.cengage.com/mindtap.

Online Instructor's Manual

An online Instructor's Manual accompanies this book. It contains information to assist the instructor in designing the course, including sample syllabi, discussion questions, teaching and learning activities, field experiences, learning objectives, and additional online resources. For assessment support, the updated test bank includes short-answer and essay questions for each chapter.

PowerPoint Lecture Slides

These vibrant Microsoft PowerPoint lecture slides for each chapter assist you with your lecture by providing concept coverage using images, figures, and tables directly from the textbook.

Cognero

Cengage Learning Testing Powered by Cognero is a flexible online system that allows you to author, edit, and manage test-bank content from multiple Cengage Learning solutions; create multiple test versions in an instant; and deliver tests from your LMS, your classroom, or wherever you want.

Acknowledgments

Developing the sixth edition of *Science Stories* required a close look at the Next Generation Science Standards and its impact on science teaching and learning. The three-pronged approach to science education is reflected by the important stories in this text. Examining the disciplinary core ideas, science and engineering practices, and crosscutting concepts gave new meaning to the stories as they unfolded. Many thanks to Yael Wyner, whose use of electronic resources to develop middle school curriculum in ecology and whose visionary work using Leafsnap informs stories in Chapter 4. Many thanks to Jo Ann Caplin for sharing her remarkable work on *La Bella Principessa*, which informed the story in Chapter 11 and revealed more fully the interdisciplinary nature of science teaching and learning. My former student Christine Bulone Toppi shared her love of science teaching that is reflected by her work on matter with her third graders in Chapter 5. My appreciation goes to Pamela Abder and Robert Wallace at New York University and the IDEAS Institute at Hofstra University.

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The preservice and in-service elementary and middle school teachers with whom I have worked helped me to understand what they needed to be effective science teachers. They also showed me that stories work!

Although it is possible for me to remember where the ideas for the text originated, it would have been impossible to turn them into a science methods textbook without the vision of Loretta Wolozin, then a senior sponsoring editor at Houghton Mifflin. She traveled to Long Island one day to convince me that these stories could make a textbook that would speak to the preservice teacher in a way no other science methods textbook could. My sincere appreciation for sixth edition goes to content developer Julia White, who stayed with me, chapter by chapter and who understands today's learners. Several reviewers also offered important guidance and feedback for the sixth edition. Sincere thanks in particular to:

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