Math and Science Investigations

Using Children's Books to Make Big Discoveries

Sally Anderson
with The Vermont Center for the Book

Math and Science Investigations

USING CHILDREN'S BOOKS TO MAKE BIG DISCOVERIES

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WITH THE VERMONT CENTER FOR THE BOOK

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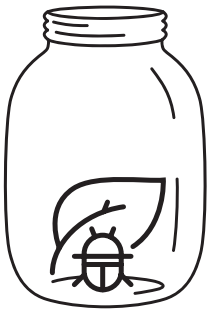

CHAPTER 1

Introduction

Welcome To *Math and Science Investigations*

This book will support and enhance the work you are already doing with young children. In it you will find hundreds of ideas for using high-quality picture books, good conversations, and lively investigations that incorporate the skills, concepts, and standards of mathematics, science, and language and literacy.

In addition, this book will help you work with children in ways that are interesting and fun to them and sensitive to their developmental needs.

Children are naturally compelled to explore the world around them. By providing tools and support for children's active exploration, you can promote the development of mathematics, science, and language and literacy learning. By observing and documenting this learning, you can share with administrators, peers, and families the learning that is taking place within each child.

Math and Science Investigations will enhance your work with young children by helping you to:

- Use the language of math, science, and literacy in your daily practice and programming,
- Use picture books and investigations to promote conversations, language skills, and higher-order thinking,
- Engage children in hands-on investigations that help them explore math, science, and literacy skills and concepts,
- Find diverse ways to use picture books for all kinds of learning,
- Learn how to use math, science, and language and literacy standards to inform your work with children,
- Observe individual children and groups of children more carefully,
- Learn ways to communicate to families the work you are doing with children,
- Enjoy your time with children and continue to grow in your profession, and
- Understand that you enrich the lives of young children.

Using *Math and Science Investigations* will help you work with children with more intention, talk about your work with more clarity, and address standards more thoroughly. *Math and Science Investigations* will help you build on what you already know about mathematics, science, and language and literacy.

How This Book Is Organized

Each remaining chapter of *Math and Science Investigations* focuses on a topic that relates to both mathematics and science. The chapters are as follows:

Chapter 2: Measurement, Data Collection, and Graphic Representation

Chapter 3: More than Counting

Chapter 4: Out and About

Chapter 5: Shapes and Spaces

Chapter 6: Exploring Spaces (and Places!)

Chapter 7: What Comes Next?

Chapter 8: Growing and Changing

Chapter 9: Same and Different

Chapter 10: Making It Work

Each chapter begins with a general introduction to the theme: ideas to start you thinking about math, science, and language and literacy; vocabulary related to the topic; and picture book suggestions. The introduction also answers these important questions:

- How does the theme respond to young children's curiosity and interest?
- How does the theme relate to young children's development?
- How does the theme relate to math, science, and literacy?

INVESTIGATIONS

The introduction to the theme is followed by two or more investigations. Investigations are experiences that engage children in math, science, and language and literacy learning. Investigations are meaningful learning experiences that are done over and over again. They are child-centered, they build children's selfconfidence, and they deepen children's understanding of skills and concepts.

Each investigation begins with a summary of what children will do and learn during the investigation. Most also offer picture-book suggestions. Investigations are divided into these subsections:

What's Needed: Materials needed to do the investigation

Things to Consider: What you'll want to think about before beginning the investigation

Key Standards Children Practice: Standards highlighted in this investigation

Step by Step: How the investigation should proceed

Talk with Children: Open-ended questions and comments to stimulate children's language and thinking during the investigation

Observe Children: Questions to ask yourself about children's language and behaviors as you observe children during the investigation

Extend the Learning: Ways to deepen and extend the investigation to enrich children's math and science learning

Connect with Families: Information to display and post about children's learning during investigations

The chapters and investigations are not cumulative. Pick and choose individual investigations or a series of investigations that can be easily integrated into your curriculum, that address the children's interests, or that explore an event that a child or the class experienced. Keep in mind that all books, conversations, and investigations can be repeated.

Why Use Picture Books to Introduce Math and Science?

Stories are a powerful way to introduce math and science to children. Researchers recommend using picture books to develop math and science skills and understanding because picture books:

- Provide a story context for math and science content;
- Suggest manipulatives for a variety of math and science investigations;
- Pose problems that can be explored using varied strategies;
- Develop math and science concepts;
- Encourage the use of math and science language;
- Modify story situations to develop math and science thinking;
- Introduce new vocabulary;
- Enhance phonological awareness through repetitive patterns, rhymes, and refrains;
- Introduce complex sentence structures;
- Help children understand themselves and others;
- Help children make sense of their world; and
- Encourage children to recreate stories in their own words.

Stories bring math and science to life. They can help children learn how to use math or science skills and knowledge to address their own real-life problems as they arise. At the same time, children are developing critical language development skills.

The Importance of a Diverse Book Collection

When we recommend books in this guide, we have selected them to reflect the diversity of the world. This means that we look for good, well-reviewed picture books that strike a balance of gender, ethnicity, and place.

Diversity plays an important role in choosing and reading picture books, but we never isolate these books or categorize them according to the demographic they may reflect. Nor do we choose books simply because they represent a particular culture. Story, art, and publishing excellence are always the primary criteria. In all books recommended in this Guide, the characters share the same needs and desires as the young children in your care: they want to explore the world and learn new things, they want to be loved, and they want to feel safe—but they want to have adventures, too.

USING NONFICTION BOOKS

In addition to using picture books to introduce a math or science idea, you may want to delve further into the facts by using nonfiction books. For instance, you could pair Chris Van Allsburg's *Two Bad Ants* with a good nonfiction book about ants.

Nonfiction books present facts and photographs or scaled drawings about a subject. Here are some things to consider when using nonfiction books:

- Nonfiction books are not meant to be read aloud from cover to cover. Before you use a nonfiction book, read it from cover to cover as you would with a picture book. Choose the parts of the book that reinforce, extend, or otherwise add to the concept you and the children are exploring.
- Give the children time to look closely at photographs and illustrations. Read the captions to them to help explain what they are looking at.
- Stop reading after a few facts and talk about them.
- Use the nonfiction book to compare and contrast with the picture book. Do the ants in the photo look like the two bad ants? How are they the same? How are they different?

THE IMPORTANCE OF VOCABULARY DEVELOPMENT

The research is clear: the more words a child knows before he or she enters school, the more successful learning will take place for years to come. Reading is important, but complex conversation is key. In your everyday activities with children, use precise language as you ask questions or describe objects or events.

Introducing Picture Books

Throughout *Math and Science Investigations* we have suggested picture books for you to use with the children. What follows are suggestions on how to introduce two picture books to children. Both *Lottie's New Beach Towel* by Petra Mathers and *Bein' with You This Way* by W. Nikola-Lisa are excellent picture books in their own right. However, embedded in both stories are simple math and science concepts.

Lottie's New Beach Towel by Petra Mathers

Little does Lottie realize that the beautiful new beach towel her Aunt Mattie sent her will help her solve problems. After all, Lottie's just planning to enjoy a day at the beach with her good friend Herbie—what could go wrong? But when she first steps on the hot, hot sand, she confronts the first of several problems she'll use the beach towel to solve.

Lottie uses the same problem-solving skills that mathematicians and scientists use.

VOCABULARY

ingenuity: cleverness. When children are clever at solving problems, use the word *ingenuity* to describe what they are doing.

problem: a difficult situation. This book is about solving problems. When we solve problems in our daily lives:

- We observe a situation,
- We raise questions,
- We make predictions and a plan,
- We try the plan, and if the plan doesn't work...
- We make a new plan, and
- We try that new plan.

MAKING CONNECTIONS

Before you read *Lottie's New Beach Towel* with the children, show them the other books you've read together. Talk about the problems in the stories and how the problems were solved. You might start with these books:

Bunny Cakes by Rosemary Wells

The Doorbell Rang by Pat Hutchins

Seven Blind Mice by Ed Young

For each of these, discuss how the problem was solved and what some other solutions might be.

INTRODUCING THE BOOK

Begin reading *Lottie's New Beach Towel* by looking at the front cover and the endpapers together. Ask questions such as the following:

What do you notice about the cover?

What do you notice about the endpapers?

What does the front cover tell us about the book?

Can you learn anything new from the back cover?

Next, look at the picture of the opened package on the title page.

Make sure to read what is on the address label and talk about it—some children may not know that what's printed on a package tells where it should be delivered.

Then tell the children they're going to observe carefully and make a prediction. Ask questions such as the following:

What do you see in the picture?

What do you think will happen in the story?

READING AND TALKING TOGETHER

Read *Lottie's New Beach Towel* with as few interruptions as possible so that the children understand the story. After reading the book several times, act it out with the children. Use props in the classroom such as a blanket for a beach towel and retell the story. Let the children take turns being Lottie, Herbie, and the other characters.

Lottie's New Beach Towel provides a wonderful opportunity to talk about problems and solutions long after you've read the book with children. When a child has a problem—for example, not being able to find

something—take the time to point out that this is a problem to be solved. It can be solved by taking specific actions, and there may be more than one solution to the problem. Ask questions such as the following:

What is the problem?

What are some ways it might be solved?

Which way will you try first?

Pair *Lottie's New Beach Towel* with investigations such as "What Would You Do If…?" on page 121 and "How Does It Help Us?" on page 123 in the Making It Work chapter. Lottie's problem is a great jumping-off point to math and science investigations focusing on problem solving.

Lottie's New Beach Towel by Petra Mathers

In *Bein' with You This Way* by W. Nikola-Lisa, a young girl leads a cumulative rap about individual differences. The playground is a perfect setting for this exuberant story.

This original verse has a challenging and inviting beat. The wonderful, rhythmic chant is about all the ways people are the same and different. Make sure you practice reading *Bein' with You This Way* aloud before you read it to children.

VOCABULARY

electrifying: exciting or stimulating. Vocabulary building can be part of conversation. When a child has a good idea or paints a bright picture, say: "Now, that is simply electrifying!"

enraptured: filled with delight. Children are enraptured by a good story well told.

MAKING CONNECTIONS

Before reading *Bein' with You This Way* to children, ask your group to look at what the children are wearing on their feet. Some are probably wearing sneakers and some are not. *I'm going to sort our entire group into two different groups.*

Now sort the children by putting (without telling them why!) the "sneakered" children in one group and the "sneakerless" children in another. *Can anybody figure out what attribute I used to sort you?*

Do this several times, using different attributes. Always give the children plenty of opportunities to discuss what they think the attributes are. Encourage the children to use good descriptive words. Older children may want to choose attributes and do the sorting themselves. Sorting options are endless, but do not sort children by physical characteristics.

INTRODUCING THE BOOK

Show the children the cover of the book. Notice that the picture on the front cover extends to the back cover. Talk with your group about feelings, the weather, and the location when looking at the cover.

What do you notice about the playground?

What do you notice about the children?

Look at the title page of the book together. Ask:

What do you notice about this group of children?

READING AND TALKING TOGETHER

After you've read *Bein' with You This Way* a few times, encourage the children to participate in this call-and-response story. Pause and invite children to say, "Uhhuh!," "Mm-mmm," and "Ah-ha!"

Engage the children in a conversation about same and different. Here are some questions you might ask:

How is this red marker the same as this red toy car? How is it different?
How is a flashlight the same as a lamp? How is it different?
How is a dog the same as a person? How is it different?
How is a bicycle the same as a car? How is it different?

Go on a "Same and Different" hunt. Allow the children plenty of time to find two objects that they think are the same and different.

Come back together and have the children talk about what is the same and what is different about the objects they found. Some children may want to talk about objects that cannot be easily moved, such as a window and a mirror. Encourage the children to point to these objects and talk about them to the group.

You might continue this investigation outdoors. Tell the children to use their observation skills to look for objects (living and nonliving) that are the same and different.

Pair *Bein' with You This Way* with investigations such as "What's the Rule?" on page 110 in the Same and Different chapter of this book.

How Young Children Learn

Young children learn through exploration. Children explore in hundreds of different ways. For young children, learning takes place everywhere and all the time. You can observe children exploring when they do the following:

- **Repeat actions over and over:** Chloe works on the same puzzle over and over.
- **Lift things up and look underneath:** Olivia turns over the rocks in the park.
- **Ask questions:** Isabella asks, "Why does the fish make bubbles?"
- **Use materials and tools in creative ways:** Juan uses a piece of rope to measure a tower of blocks.
- **Watch things intently:** Mia likes to watch the hamster running around and around on its wheel.
- **Make predictions:** Noah guesses that a raccoon might live in a hollow log.
- **Solve problems:** Maria substitutes two small blocks for one bigger one.
- **Represent real objects:** Jayden draws two parallel lines, connects them, and says, "It's a train track!"
- **Make comparisons:** Ethan uses the small blanket to wrap up the smaller of two dolls and a bigger blanket to wrap up the larger doll.
- **Sort objects:** Jacob separates a collection of buttons into two groups: metal ones and plastic ones.
- **Make connections:** Emma tells some friends to make playdough pies that look like the pies in a book they listened to at story time.

It is not difficult to become an effective math and science teacher for young children. Chances are good that you and the children are already doing many science- and math-related activities as you go about your day. Here are ways to encourage mathematics and science learning in everyday situations:

- Setting the table for lunch is a chance to count and create a pattern with the napkins, utensils, and dishes.
- Going outside to play means being able to observe and talk about plants, the sun, shadows, wind, or gravity, just to list a few possibilities.
- Watching the fish in the aquarium or the hamster in its cage provides a wonderful opportunity for comparing and contrasting two different living things.
- Cooking up a batch of cookies requires counting, measuring, combining solids and liquids, and using all of the senses!
- When it's time to go home at the end of a busy day, children can recall the sequence of the day and predict what tomorrow might bring.

This book will help you (and the children with whom you work) become more aware of and purposeful about the math and science that you do every day. You will find yourself talking about these skills, using the appropriate vocabulary, and having fun exploring other ways to do routine activities!

The investigations presented in this book support children's learning by engaging them in three important components of learning: actions, conversations, and thinking.

Math, Science, and Language and Literacy Standards

Standards help educators bring focus and intention to their work with children. This book emphasizes both content (knowledge and ideas) and process skills (behaviors and thinking) in the mathematics, science, and language and literacy areas.

More and more, educators are being asked to learn about standards and incorporate them into their work with children. When used appropriately, standards have a positive effect on children's learning. Standards are designed to answer these questions:

- What should children learn?
- When should they learn it?
- What outcomes can be expected?

Keep in mind that for young children, we want to create learning environments that encourage reaching toward these kinds of ideas.

Professional organizations such as the National Council of Teachers of Mathematics (NCTM), The National Academy of Science (NAS), and the National Council of Teachers of English (NCTE), as well as most state departments of education, have created and published sets of standards for a range of age and grade levels. State and local standards can be easily accessed on the Internet.

The following pages detail early childhood standards for mathematics, science, and language and literacy. They are defined in a way you will find meaningful and useful in your work with young children. You can easily make connections between these standards and your own state or local standards and the Head Start Framework of Outcomes.

As you become familiar with these three sets of standards, you will notice that they overlap and interconnect. This is the nature of learning—it doesn't fall into neat little separate bundles. Math skills help us with science, science skills help us with math, and language and literacy skills help us in all areas.

MATHEMATICS STANDARDS

In Principles and Standards for School Mathematics, the NCTM sets forth standards in 10 areas that cover a broad range of math skills and understandings—five are identified as process standards and five as content standards.

THE PROCESS STANDARDS

Learning mathematics requires action and thinking. NCTM has identified five processes that are especially critical to learning about mathematics: problem solving, reasoning and proof, communicating, making connections, and representing.

- **Problem Solving**

  For young children, this includes using simple approaches to solving mathematical problems: asking for help, counting, trial-and-error, guessing-and-checking.

- **Reasoning and Proof**

  For young children, this includes learning to explain how they solved a mathematical problem: describing the steps taken verbally, in a drawing or with concrete objects.

- **Communicating**

  For young children, this includes the following:

  - Telling others about their math-related work: using language, pictures or other symbols, or concrete objects
  - Beginning to use some math language: numbers, shape names, size words, names of math materials, and so on

- **Making Connections**

  For young children, this includes the following:

  - Using math skills in a variety of situations, not just when prompted by an adult
  - Linking their own math experiences to those of other people, in real life or in books
  - Recalling previous math experiences when engaged in current ones

- **Representing**

  For young children, this includes using simple pictures, graphs, diagrams, or dictated words to represent their mathematical ideas.

THE CONTENT STANDARDS

- **Numbers and Operations**

  For young children, this includes the following:

  - Recognizing and naming some written numerals
  - Having a sense of quantity: knowing that the number name "three" and the symbol "3" mean three of something
  - Counting: learning the sequence of number names (1, 2, 3)
  - Counting objects: learning to count an object only once, using one-to-one correspondence in counting objects and matching groups of objects
  - Beginning addition: adding two groups of concrete objects by counting the total

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Children's books and hands-on investigations bring math and science concepts to life!

Young children are naturally interested in the patterns and processes occurring in the world around them. They are beginning to learn about the changes happening each day, month, and season. They are starting to ask questions about their environment and the world beyond. They are curious about the large and small animals they encounter.

Math and Science Investigations supports young children's natural curiosity and encourages them to explore what happens around them. Hands-on investigations help children learn the skills, concepts, and standards of mathematics, science, language, and literacy—all at the same time—using their favorite books. Themes include Exploring Spaces (and Places!), Out and About, Growing and Changing, and What Comes Next?

Each investigation includes the following:

- A list of the materials needed
- Standard addressed by the activity
- Step-by-step instructions of what to do
- Open-ended questions and comments to stimulate children's language and thinking skills
- Observation guidance to use during each investigation
- How to deepen and extend the investigation
- How to connect the investigation with the children's families

About the Author

Sally Anderson is the founder and president ex officio of the Vermont Center for the Book, an affiliate of the Center for the Book in the Library of Congress. She has created professional development programs for early childhood educators and librarians across the country, including courses centering on math, science, social studies, and early literacy. Sally is the recipient of many awards and honors, among them the Hope S. Dean Memorial Award from the Foundation for Children's Literature, the Lyman Hunt Jr. Award from the Vermont Council on Reading, and a Special Recognition Award from the New England Reading Association.

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