CHAPTER 1

So This *Is Science!*

BARBARA BOURNE

I NEVER LIKED science as a child—or so I thought. It was, in a word, boring. I preferred the out-of-doors to the classroom; was far more attached to exploration than memorization.

My fondest childhood memories are of the out-of-school hours I spent with my brother, unlocking the mysteries of the woods and streams behind our home. We knew each tree intimately—which ones were the sturdiest for tree houses; which were too sticky with pitch to climb while wearing school clothes; and which lost their leaves too early in the fall to provide sufficient camouflage for secret meetings.

Our clothes were perpetually muddy and our shoes forever wet. In the spring we collected tadpoles in our grandmother's old enamel tub and tracked the survivors' metamorphosis into tiny frogs that we released back into the wild. We devised elaborate plans to change the course of nature, but continually discovered that we were no match for the immutable forces we worked so hard to alter. Many hours were spent trying to straighten the course of a meandering stream. Many days were spent trying to dam that stream into a pond. And many dimes were spent at Woolworth's before we realized that ten-cent goldfish just weren't going to survive in cold Massachusetts waters.

Regular Saturday excursions to nearby beaches provided us with a comfortable familiarity of the shoreline—with snails, crabs, and sand dollars; with wind, waves, and the therapeutic (but painful) effect of salt water on that week's newest crop of bug bites and poison ivy. After autumn and winter storms, we'd return to the beach and marvel at the strength and fury displayed by the very same ocean we'd playfully splashed in a few months before.

When family trips and outdoor play ceased to be "cool," I went off to summer camp, where I found a built-in cohort of fellow adventurers to share in an ever-widening exploration of our outdoor home. We lived in the woods. We canoed each cove and inlet. We climbed New England's tallest mountain and threw snowballs near its summit in July. We fell

asleep under the stars and, damp with dew, awoke to the sounds of the birds. Our shared experience of living outdoors not only forged lifelong friendships, it also cemented a lifelong love of the natural world.

But carefree summers inevitably led to routine Septembers and the return of textbooks and tests. When well-meaning adults pulled out that standby conversation starter, "What's your favorite subject in school, dear?" my reply was quick and well rehearsed. "I'm not sure, but I know what I don't like—science!" My later school experiences did nothing to contradict my early impressions, and I took pride in the growing number of science classes I *didn't* take while completing school.

Little did I realize the depth of my naturally acquired understanding, the intimate knowledge I'd gained of the world, or the authenticity of my scientific experiences. Little would I have predicted that as an adult I'd be fascinated with the very subject I'd avoided for so long and even end up working in a program with the word "science" in its title.

Coming Home to Science

The Elementary Science Integration Project (ESIP) has offered a home to many unrealized scientists like myself, adults who for years have avoided taking or teaching science, but who nonetheless nurture a lifetime of scientific experience. In ESIP, teachers with expertise in science work alongside those whose strengths are in language arts and literature as together they explore the connections of science to their own lives and its potential impact on their classroom practice.

Second-grade teacher Debora Lang referred to her ESIP experience as an opportunity to find her "science self." This personal journey moved Debora from being simply a language/literature/arts-focused teacher to being a more science-focused *person.* Her interests were sparked during an ESIP institute of inquiry and reflection and then nurtured by travel and reading—and by exploring the world of science alongside her students.

Over the past nine years, ESIP records have documented how a large number of participants have turned to the outdoors as a comfortable place to begin their entry into classroom science. Perhaps they do so because they, too, harbor an unrealized "science self," one that is already in tune with the science and aesthetics of the natural world.

Betty Lobe, a twenty-three-year teaching veteran, is representative of the many ESIP participants who, on entering the program, viewed themselves as "very knowledgeable" in the teaching of reading, writing, social studies, and/or the arts, but saw themselves as "weak" in the sciences. It's interesting to note that although Betty's ESIP application stated

numerous times and in numerous ways that she did not view herself as competent in science, she actually did possess a wealth of scientific interest and knowledge. She'd taken several outdoor education courses and, along with her husband, was a bird-watcher and a member of the local zoological society.

Furthermore, it was clear from her application that she already valued the qualities necessary for teaching science in the classroom. "I am more patient, more thoughtful, more reflective, more of a guide on the side," she wrote. "My confidence allows me to not have all the answers, therefore I am a listener . . . I enjoy teaching more than ever because it has become a great adventure for me."

Despite her underlying knowledge and interest, Betty's venture into the world of science loomed as a personal challenge. She struggled with her identity as a scientist and as a science teacher during her first ESIP summer but, as the following journal entries reveal, she gradually began to recognize her own "science self" hidden within the love of nature that emerged as her first comfort zone. Taking children outdoors became a starting place for science in her classroom.

July 12, 1996
I do not think of myself as a scientist and I feel very uncomfortable teaching science. However, I feel that changing. I love the out-of-doors and nature and have taken outdoor education courses. When I pair that knowledge with all the wonderful books that you surround us with, I immediately feel more comfortable.

I do and can do journal writing. I can take my students for nature walks and have them respond in writing. I can get copies of Jean Craighead George's books, in fact, I've already read some and in the 5th grade we [study] ecosystems. I've already arranged for the entire 5th grade to board various boats with the Living Classroom Foundation. I have a willingness and a desire and now I need to learn how to set the stage to provide my students with the opportunities and skills to format and investigate the questions I know they have.

July 16, 1996
I [am] more aware of my need to bring science home to my own backyard and theirs. I keep thinking of the . . . tree outside of my classroom. We sit under it to read and write, we predict the dropping of its beautiful leaves, we watch the birds at rest in its boughs and take beautiful pictures of ourselves under it, but I bet none of us knows its name.

I guess that is where authentic inquiry comes into play. That tree is really important to me and my kids in many ways and it would be easy to

incorporate that tree into my ecosystems unit. I need to bring it home. If my science is to be rigorous and relevant, I need to bring it home.

The science in Betty's classroom was indeed rigorous and real as it took dramatic turns the next school year. September began with simple explorations of their schoolyard habitat, but students' questions soon took off in multiple directions, weaving in and out of the mandated curriculum. In an end-of-year journal entry, Betty reflected on the work the class had done.

May 10, 1997
Mornings before school are periods of rush and confusion for many of my students, so I chose to begin each day with a Native American tale. It began our thinking in terms of Mother Earth and because we were scientifically exploring our school grounds, it appeared to be a thought-provoking, yet calming, way to begin our day . . .

The gathering for me [started as] an attempt to build community within my group and allowed me to move quietly into the background. It became much more. I saw it emerge as a clearinghouse for ideas, spark new investigations, and become our classroom think-tank. The students began to share their own reading selections and their investigations. During the unstructured moments (break, transition, recess) everyone was busily engaged in meaningful activity. Students were investigating their own questions and these 5th grade students exhibited that remarkable gift of child-like wonder . . .

"To thine own self be true and then as sure as night follows the day, thou cannot be false to any man." That schoolyard was my security blanket in those early months. I loved the out-of-doors, had taken outdoor education classes and felt it was the natural setting for me to investigate and explore with my students.

Science from Nature: Starting as a Child

Coming to science through outdoor exploration seems a natural thing to do—especially for a child. Some would argue that a comfort with nature is inborn. In fact, noted naturalist E. O. Wilson has coined the term "biophilia" for that innate love of nature and affinity for other forms of life. In his autobiography he describes his own childhood exploits and explorations of the world around him as critical to his development as a naturalist and writer. After giving detailed accounts of his childhood encounters with various creatures of the sea, Wilson writes:

Why do I tell you this little boy's story of medusas, rays, and sea monsters, nearly sixty years after the fact? Because it illustrates, I think, how

> a naturalist is created. A child comes to the edge of deep water with a mind prepared for wonder . . . The waterland was always there, timeless, invulnerable, mostly beyond reach, and inexhaustible. The child is ready to grasp this archetype, to explore and learn, but he has few words to describe his guiding emotions. Instead he is given a compelling image that will serve in later life as a talisman, transmitting a powerful energy that directs the growth of experience and knowledge. (Wilson 1994, pp. 11–12)

Unlike E. O. Wilson, many of us (Betty and myself included) weren't encouraged to make those connections between "real science" and the less academic pursuits of a home-grown naturalist: sloshing through streams and then stooping to inspect an egg sac floating on the surface; quietly watching birds and building a familiarity with their habits and songs; relishing that musky, morning aroma that arises from a damp woodsy floor. Rather than recognizing the importance of science in our lives, we tended to recoil from anything "scientific" and believed that *we* didn't have the stuff of scientists, nor were we capable of sharing science with others.

Rachel Carson addressed this dilemma in her final book, *The Sense of Wonder:* "The lasting pleasures of contact with the natural world are not reserved for scientists, but are available to anyone who will place himself under the influence of earth, sea, and sky and their amazing life" (1956, p. 95). Carson recognized children's inborn curiosity and awe over the natural world, but also understood that the excitement can fade as children mature into adults. "If a child is to keep alive his inborn sense of wonder," she writes, "he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in" (p. 45).

The teachers who contributed to this book have taken on Rachel Carson's challenge. They have moved beyond the classroom walls and are providing their students with authentic, real-world experiences. Some of the teachers have tapped into a lifelong love of nature while others are venturing out for the very first time, sharing the initial wonder of discovery right alongside their students. The children, in turn, are the direct beneficiaries of their teachers' evolving connection with the natural world. Going outdoors is immediate and real; it sparks questions; it offers avenues of exploration and investigation; and it is available, at little or no expense, to everyone.

The stories in this book are about more than just stepping out the door, more than simply letting children interact with the flowers, trees, and the great and small creatures of their neighborhoods. To twist a well-worn phrase from Henry David Thoreau's *Walden,* these chapters are

documentaries of how teachers and students go to the woods (and the ponds, streams, and fields) to learn deliberately and to confront the essential facts of life. Children who go outside regularly begin to notice the cycles and patterns of nature, the habits of animal life, the beauty of the world around them. Learning from routine outdoor experience is not just deliberate, it is natural. It balances the intentional with the casual, the planned and the serendipitous. It builds on children's intrinsic curiosity and their need to interact with real objects and events.

Nature and Inquiry: Natural Connections

Questioning, exploring, investigating, manipulating, problem solving, communicating, reinventing understanding: these are the hallmarks of childhood—and they are the processes of scientific inquiry. The struggle to make meaning of the world begins in infancy and, for some at least, never ceases. Inquiry is a valuable means of addressing children's learning needs within the classroom. In fact, "Science as Inquiry" is the very first content standard for all grade levels (K–4, 5–8, and 9–12) as established by the *National Science Education Standards* (1996). For example, here is how the K–4 Inquiry Content Standards begin:

> From the earliest grades, students should experience science in a form that engages them in the active construction of ideas and explanations and enhances their opportunities to develop the abilities of doing science . . . As students focus on the processes of doing investigations, they develop the ability to ask scientific questions, investigate aspects of the world around them, and use their observations to construct reasonable explanations for the questions posed. Guided by teachers, students continually develop their science knowledge. (p. 121)

Children in the classrooms featured in this book are engaged in the very processes the *Standards* advise. They are constructing ideas and formulating explanations. They are honing their abilities to ask scientific questions through direct observations of the world around them. They are using their observations to construct reasonable explanations and revisiting the objects of their investigations over the course of time. But these events don't "just happen."

Structuring Inquiry

Inquiry science is often associated with a lack of student accountability, with little teacher planning, and with scant attention to, or correspon-

dence with, student learning outcomes. Fear of chaos, confusion, and disorder keeps many teachers from inviting inquiry into their classrooms and many administrators from encouraging its use in their schools.

ESIP teacher Susan Wells first began experimenting with classroom inquiry in 1992 and was initially very reluctant to let her students identify and explore questions that were important to them. Gradually, she found strategies that allowed her students to explore their own questions, that let her maintain a level of accountability, and that helped all of them to move through—and beyond—the district's curriculum. Susan's inquiry-based program of study addressed all of the science and many of the language arts, social studies, and mathematics outcomes called for in the curriculum. "Over the years," Susan explained in a recent workshop, "I found myself becoming *less controlling* and *more structured.*" By imposing a structure on their students' inquiry experiences, Susan and other teachers are making sure these young scientists have the opportunity to make meaning of the science they are encountering.

In structured inquiry, both indoors and out, children are encouraged to investigate the questions that are important to them, but they are also required to meet certain guidelines before, during, and after their period of investigation. Every student needs a plan before starting. They all must be able to articulate *what* they are doing and *why* they are doing it during their investigation time.

Science in these classrooms is more than just "doing," more than "hands-on." Students write, read, listen, and share their discoveries and questions with others. Notes are kept, data collected, questions recorded, and observations documented. At the completion of each day's work, the class might convene in a scientists' meeting, where student-scientists share the results of a single or ongoing investigation. Other students respond to the data and conclusions and may offer suggestions or new questions to explore. This discourse helps children critically review their own experiences, place these experiences within the larger context of group findings, evaluate and compare data, generalize concepts, and, best of all, come up with new questions to explore.

Outdoor Inquiry: More Than a Breath of Fresh Air

Science in the out-of-doors must be held to the same standards as science conducted within the school building. There should be a plan and there should be a purpose. ESIP teacher Jeanne Reardon states in *Beyond the Science Kit: Inquiry in Action* (1996) that the science in her classroom must be "real, relevant, and rigorous" (p. 18). Few experiences are more

real and relevant than taking children outside to explore their immediate environment, but it takes careful planning by teachers to ensure that outdoor experiences incorporate rigorous science. A trip to the pond or a walk in the woods might be fun, but it is little more than a breath of fresh air if children are not given the tools to make meaning of their experiences.

On the same day that I joined Lorraine Russo's students on the first of their weekly trips to a local lake, a colleague told me that she'd also joined a first-grade class on a nature walk. She was disappointed that the student teacher hadn't felt the need to make plans beyond sending home permission slips and arranging for chaperones. The children held hands, walked through the woods, and collected some leaves and pinecones to add to their "nature table." There was no advance preparation and little follow-up when they returned to the classroom. The children had a great time, but they weren't encouraged to make any new meaning of their natural world as they walked and talked.

Lorraine Russo (see Chapter 2) began preparing her first graders for their trips to the pond weeks in advance. After a brief visit to the school's courtyard, she realized that five- and six-year-olds needed to practice the skills that would make them successful scientists at the lake. They learned to sit quietly so they wouldn't trample the plants or chase away the insects and birds they'd come to observe. They practiced looking at tiny details and listening for quiet sounds. They learned how to collect data, they read books about pond life, and they collected the tools and supplies they would need to conduct their investigations.

Like all the teachers featured in this book, Lorraine had no idea what her students' questions would be, how their investigations would evolve, or how the children would communicate their findings. But she had a substantive plan in place that was designed to support her students' emerging inquiry. As you'll read in her chapter, Lorraine's plan continually evolved, shifting to reflect the needs of the students and their investigations. It encompassed all content areas and involved her first graders in reading, writing, collecting and working with numbers, and studying the world around them.