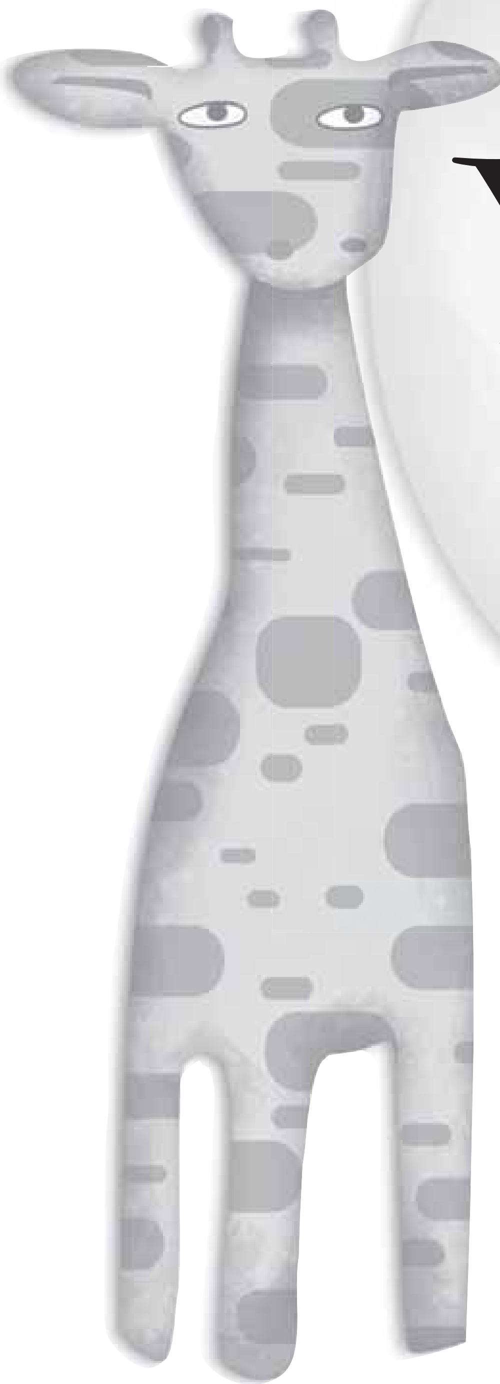

Start Young!

Early Childhood Science Activities

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Introduction

Children learn science from infancy, observing and responding to the phenomena in their daily experience. They learn about their immediate environment through their senses of sight, sound, touch, smell, and taste. When babies become mobile, they explore the world around them more rapidly. Then they start using trial and error, repetition, imitation, and classification. Children who are exposed from babyhood to a wealth of experiences through active exploration are laying a foundation for the development of science concepts later. They use science process skills as they move from observation and exploration during the toddler years to data collection, classification, representation, communicating theories, and interpretation in the preschool and primary years.

Caregivers for and teachers of young children can easily underestimate the capability young children have for science learning and miss spontaneous opportunities for supporting science learning. But they should learn to for purposeful exploration and experimentation. Children love science experiences and are fascinated by even the smallest aspect of the world around them. Seeing young children as curious, competent, and interested science learners is a good beginning. Using this book as a resource is a next step.

The National Science Education Teaching Standards (NSES) (NRC 1996) direct teachers toward high-quality science teaching with clear criteria describing what teachers can do to support science learners at all age levels. Teaching Standard A criteria tell teachers "to select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students." The articles in this book will help teachers do just that. They provide teachers with activities for young children that connect to the National Science Education Standards and will result in better science teaching and children more interested in learning.

Early Learning and Science

Current findings from brain research and a resurgence in interest in the very young child as a learner makes this an exciting time for early childhood educators, but a time not without challenges. The emphasis on literacy as an isolated curriculum area has resulted in either the virtual exclusion of science experiences for young children or a limited, surface treatment of science instruction in preschool and primary settings. This section highlights articles from authors who emphasize the need to start young and provide opportunities for science learning that use the capabilities young children bring to science investigation.

In "Start Young!" Penni Rubin relates how interviews with scientists nationwide revealed a common experience—exposure to meaningful science experiences at an early age. She suggests this knowledge can be applied in classrooms by providing interesting adult role models and classroom experiences that connect science concepts to real world careers, professionals, and daily experience. She goes on to provide useful suggestions for setting up age-appropriate career learning centers to promote interest and learning in chemistry, botany, zoology, oceanography, Earth science, and paleontology.

Science learning is enhanced through conversations among children, the focus in Marletta Iwasyk's "Kids Questioning Kids: Experts Sharing." She describes ways in which documenting the conversations of children reveals their understanding and interest and provides insights into effective questioning strategies.

In "What the Real Experts Say," a first-grade teacher describes her journey of putting theory learned in a professional development seminar into practice in her classroom. Teaching first graders the scientific process seemed impossible to Carol Avila until she tried this application of the National Science Education Standards. Listening to the responses of her students during a science demonstration, asking questions related to the students' comments, and supporting their investigation convinced her that her first-grade students were the real experts.

Young children ask important questions about the world around them. "How Big Is Big: How Small Is Small" connects National Science Education Standards to young children's questions about relative size. The vivid descriptions of second-grade students studying drawings and text, collecting data on their own observations, and demonstrating their knowledge to other students invite instant application.

Active Science Learning

The articles in this section describe science learning that is student-centered: Teachers plan learning experiences with children based upon the questions the children generate, the ideas and interest they evidence, and the knowledge and skills they bring to the classroom. Taking advantage of teachable moments takes a high level of skill and awareness, and facilitating the construction of scientific concepts is challenging. Teachers must provide thought-provoking materials and meaningful activities and do so for learners who come from a variety of cultural and ethnic backgrounds and have diverse abilities and skills.

In "The Bird," one teacher tells how she used students' finding a bird dead on the school playground to promote science learning in her classroom. "Gravitating Toward Reggio" by Josephine Shireen DeSouza and Jill Jereb gives readers insight into the Reggio

Emilia schools whose innovative, high-quality practices are drawing international attention. Schools for young children in Reggio Emilia, Italy, base their teaching practice on the premise that young children are capable of investigating important questions in depth and reflecting on their learning experiences. Teachers demonstrate respect for children as they listen carefully to children's explanations and theories, observe their learning processes, and plan experiences to expand upon their interests. These schools inspired the authors to apply Reggio Emilia principles to an in-depth investigation of forces and motion in their primary classroom.

In "Spiderrific Learning Tools," Kevin Mitchell and Keith Diem give readers a look at the Spideriffic curriculum they developed to teach broad science concepts by using real-world creatures and settings. Students are often both fearful and fascinated by spiders and hold many misconceptions about these intriguing arthropods. This article is filled with facts about spiders and practical classroom learning experiences.

In "It's a Frog's Life," Audrey Coffey and Donna Sterling offer an account of inquiry conducted by preschool learners after Coffey and Sterling took advantage of a teachable moment when frogs laid eggs in the preschool pool. Deborah Diffily, in "Project Reptile," details the advantages for learners when experiences are child-centered and integrate content areas. She describes an in-depth project of building a reptile exhibit in her kindergarten.

Every teacher works to provide learning experiences appealing and appropriate to a diverse group of students. Leslie Irwin, Christine Nucci, and Carol Beckett, in "Science Centers for All," emphasize the importance of equity in science learning and suggest strategies for effectively supporting diverse learners. They describe using science centers to provide challenging, high-interest, open-ended science investigations and give suggestions for promoting collaboration, allocating space, and selecting materials.

"A Science Night of Fun" from Katie Rommel-Esham and Andrea Castellitto involves the community—teachers, students, families, and members of the community experts in the field—in science learning.

Integrating Curricula

The younger the child, the more integrated his or her learning experiences can be. Integrating a high-interest, concept-laden subject area such as science into language, literacy, and mathematics learning increases student engagement and allows for more natural application of knowledge and skills to real-life tasks. Process skills are similar across areas of the curriculum, so practice with the skills of observation, exploration, inquiry, data collection, reflection, and interpretation can take place throughout the school day and across content areas.

Phyllis Whitin details bird-watching in "First Flight" as a yearlong kindergarten classroom investigation aimed at learning about the nature of science and the real-life tasks of scientists. "Tracking Through the Tulips" by Dorothy Davis tells about an online learning experience supported by funds from a Toyota Tapestry Grant —coupled with planting experiences—both real and virtual—that connect to the Standards.

Ingrid Chalufour, Cindy Hoisington, Robin Moriarty, Jeff Winokur, and Karen Worth describe how preschool children conduct inquiry while exploring relationships and discovering properties of materials in "The Science and Mathematics of Building Structures." They emphasize how experiences that normally take place in classrooms offer the richest science inquiry.

Inquiry is key in "Discovery Central" as Jaimee Wood shows how she supported critical thinking in a kindergarten classroom using a plant unit with integrated experiences such as sorting, painting, listening, and writing. Similarly, in "Ladybugs Across the Curriculum," Christina Dias Ward and Michael Dias describe a crosscurricular experience with ladybugs and detail how they addressed multiple intelligences through the project.

Gina Sarow used a learning model, Design Technology: Children's Engineering, to supplement the regular curriculum each month with design technology learning. "Miniature Sleds, Go, Go, Go!" describes the projects students constructed while using real tools, drawing their plans or blueprints, and building their models.

In "Journey Into the Five Senses," Susan McWilliams, while a doctoral student researching inquiry teaching and learning, witnessed a primary teacher of K–2 students take them on a journey through the five senses. She describes how hands-on experiences, field trips, guest experts, and books promoted the development of conceptual understanding.

Assessing Understanding

The NSES emphasize learning and assessment as a simultaneous process in that teachers plan for assessment at the same time they plan the learning experiences. Diverse strategies for authentic classroom assessment assure that all learners have opportunities to show in a variety of ways what they know and can do. Student demonstrations, representations, presentations, documentation, and samples of work are examples of multiple methods of classroom assessment that accommodate diverse learning styles. Ongoing, formative assessment provides a window to student learning that informs teacher planning and the implementation of meaningful and relevant science experiences for the children.

Assessment that helps teachers identify conceptual understanding before and after a set of lessons, or a unit, and helps them determine where misunderstanding or misconceptions exist in individual children leads to more effective instruction for transfer and learning that lasts. Assessment embedded in the learning experience, in which students are assessed while they are learning, makes the most of instructional time. Assessment that is transparent to students supports their learning by helping them reflect on their own learning styles, accomplishments, and goals. Assessment of problem solving and critical thinking helps teachers foster higher-level thinking.

"Drawing on Student Understanding," authors—Mary Stein, Shannan McNair, and Jan Butcher—describe using drawing as a tool to help students develop and document more complex understanding. They share reasons for using art as a tool for deepening scientific concept knowledge and strategies for achieving success.

In "The Tree of Life," Donna M. Plummer, Jeannie MacShara, and Skila King Brown offer time-saving suggestions for integrating academic areas through the use of children's literature, while at the same time documenting student learning in science and literacy. For example, students demonstrated their knowledge of characteristics of organisms and the use of descriptive vocabulary through artistic representation and writing.

"Students' Ideas About Plants" describes a study invited by *Science and Children* that investigated students' ideas about plants and plant growth. Charles R. Barman, Mary Stein, Natalie S. Barman, and I related study results to the Standards. A table outlining student misconceptions reveals how to teach to address the misconceptions. "Let's Try Action Research" documents another study invited by *Science and Children*. It inspired authors Ginger Stovall and Catherine R. Nesbit to replicate the Assessing Students' Ideas About Animals study (Barman et al. 1999) that determined the misconceptions students had about what makes an animal an animal and investigating whether or not a constructivist approach alters misconceptions. These two articles provide examples of assessment that contributes feedback to science educators about science learning.

"Playful Activities for Young Children" by Smita Guha and Rodney Doran ends this volume with a description of assessment tasks for younger students that demand little reading and writing—observing their science understanding through engaging activities. This approach can be applied to very young children in settings from home, to childcare and preschool.

In the Classroom

Teachers can support students through early exposure to science learning to develop a strong base for understanding science concepts, practice science process skills, and learn to explore questions about their everyday worlds using the inquiry process. Early science instruction can promote educational equity by introducing young children to the language of science, tools for science exploration, and processes for conducting inquiry.

Young children bring to the classroom natural curiosity about scientific phenomena that relates to their daily life and engage in constructive play around important science concepts. Babies explore the characteristics of objects with all of their senses and begin the process of organizing information into categories before they can speak. Toddlers are keen observers and imitators of what they see. Preschool children want to know the why and how of light switches, tadpoles, and thunderstorms. Teachers can build on this intense interest in science concepts in the early years to promote confidence and competence later in school. It is never too early to learn science.

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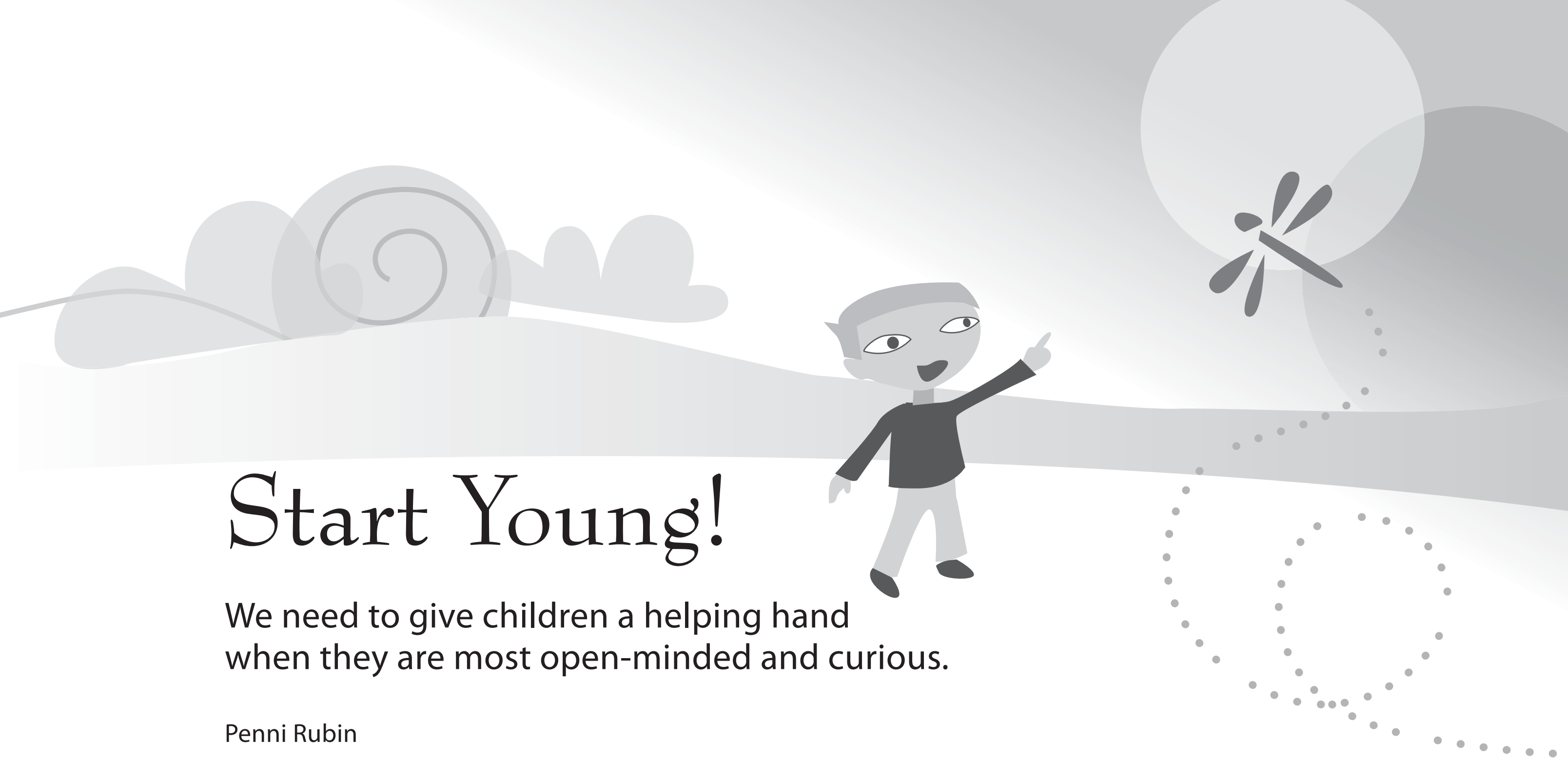

Start Young!

We need to give children a helping hand when they are most open-minded and curious.

Penni Rubin

While creating a children's science activity book for the U.S. Geological Survey (Rubin and Robbins 1992), I interviewed many scientists around the country. One question I asked of all these men and women was "When did your interest in your area of expertise begin?" This question arose because of my sister's long-standing interest in geology: As a child, she had played in the creek across the street from our house. As an adult, concepts taught in a college geology course resonated because of her childhood experiences watching the neighborhood creek change over the years.

I heard similar stories among the scientists I interviewed. For example, an oceanographer told me that it was during a vacation by the Atlantic Ocean at age seven when he first "fell in love with the ocean." Jack Horner, one of the top U.S. paleontologists, found his first dinosaur bone at age seven. I also heard from a volcanologist who knew she wanted to study volcanoes after seeing them on a trip out West with her parents when she was seven; an astronomer who remembered receiving a telescope as a child; and another astronomer who remembered using a telescope as a young child to investigate why the "Blue Moon" was not really blue. In a PBS interview, I heard Jane Goodall claiming that her favorite things as a child were the book *Dr. Doolittle* and a stuffed chimpanzee toy.

Every computer scientist, dentist, and engineer I talked with reported that, as children, they enjoyed taking things apart and building their own creations with erector sets. My sister who is a computer scientist liked to unscrew doorknobs and drawer handles with a plastic screwdriver, all at the young age of four. By age seven, she pleaded with our mother to take the car apart when our father was away at a conference. She promised to put it back together again by the time he returned.

Magic "Seven"

Through these anecdotal interactions with the scientific community and my family, I began to notice that most interests leading to a career seem to start in early childhood.

Throughout my interviews, I heard either, "at age seven I became interested in" or "I knew I wanted to do this since I was a child."

A person, place, or thing is what usually sparks those first memorable childhood impressions. Of course, we often do not study our newfound interests from the time of our personal enlightenment to adulthood, but early childhood interests are strong and they can have a powerful hold on us. Children usually show interest in many areas; but, I've observed one interest generally resurfaces as they get older. Often, it seems this interest—usually one from childhood—is the one that leads to a profession.

If children's interest in the natural world around them is heightened at a young age, why are most science education programs geared to middle and high school students? None of the numerous scientists I talked with mentioned finding their professional interests as teens or adults. They merely rediscovered their childhood interests at these ages.

In the Classroom

I strongly believe that the focus of science and mathematics exploration and activities should begin in preschool and kindergarten, before children develop negative connotations or become disengaged from the subjects. More important, early elementary school teachers and parents should exhibit a love and appreciation for science.

Some ideas for cultivating an early interest in science include the following:

> I began to notice that most interests leading to a career seem to start in early childhoood.

- Set up career-oriented learning centers in the classroom for students. Supply these centers with "STUFF"—Stimulating Tools Useful for Fun and Fundamentals. (See the box on p. 5 for ideas.)
- Invite naturalists or scientists to the classroom. Have them bring the tools they use so they can demonstrate how they do their work and students can imagine how they do their jobs.
- Encourage children to have a hobby, such as collecting leaves, rocks, or shells. Visit the library to research their collections. These experiences can lead to discoveries about other fascinating subjects on the same shelf. Provide a show-and-tell showcase for children to share their collections and perhaps spark another student's imagination.

If we want to encourage children to enter into scientific fields in the future, we need to give them a helping hand while they are most open-minded and curious. Answer children's questions with questions, such as "What do you think?" or "What do you know," to find out what they already know about a topic. Then you can guide them with some clues on how to find the answers, which makes children responsible for their own learning. It's okay not to hold all the

Early Childhood Career Learning Centers

To create a career-oriented learning center in the classroom, set up three long folding tables in a "T" or "U" shape and drape colorful plastic cloths over them.

Children tend to gravitate toward tools, so have a variety on hand, such as magnifying glasses, magnets, clipboards, graph paper, rulers, eyedroppers, funnels, and scoops. Some children also enjoy dressing up, so have swim flippers, hard hats, or a life jacket and other items for those more active students. (I once contacted a local laundry service that donated a bunch of small, white short-sleeved shirts to use as lab coats.)

The following are some career centers I've set up in classrooms:

- **Kitchen Chemistry:** Use clear containers with numbers and measuring tools to learn the properties of water. Work with gelatin, Popsicles, and pudding. Mix colors with eyedroppers and food dye or finger paint. Experiment with cornstarch and water on a cookie tray to see how a substance can be both a liquid and a solid.
- **Nutrition/Botany:** Create a storefront with plastic fruits and vegetables, empty food boxes, and a play cash register with play money. Make lists of questions about the foods such as "How does your family use plants? What plant parts do you eat?" Display pictures and posters of the good foods we eat. Collect leaves to press in a phone book.
- **Zoology:** Make a miniature zoo with stuffed animals, or hide a bunch of rubber snakes under a table with branches and a meterstick to measure and observe. Paint cardboard boxes as different habitat puppet stages and make animal puppets that would live in each habitat, using the box as a stage for a show.
- **Oceanography:** Sort seashells by bivalves and univalves with tweezers and tongs. Do crayon rubbings using textures that look like coral.
- **Earth Science:** Wet porous and nonporous rocks with water and an eyedropper. Make a sifter to separate and clean water. Create a mine shaft under a table with flashlights, pretend coal, fake gold, and a book about rocks and minerals.
- **Paleontology:** Create dig sites in clear plastic storage bins with mulch, sawdust, or gravel. Provide a bird or dinosaur skeleton picture for reference. Provide tweezers, tongs, and paintbrushes for students to sift through the debris and mark findings on grids.

While children explore these career-oriented learning centers, teachers can facilitate their learning. I use the following process:

Describe what the child is doing;

Compare something and suggest a tool;

Ask a leading question; and

Use narrative descriptive praise, such as, "When you did *this,* I noticed *that!*"

For example, at the oceanology center, the model might work something like this:

1. I saw you looking at the stingray and the sharks under the table;
2. Do you think they are also related to the whales and dolphins?;
3. I wonder if there's a chart in this book that will tell you if they are related. Shall we check it out?; and
4. I saw you reading that book. Was there something interesting that you could teach me about?

In the paleontology center, a typical exchange might be:

1. I noticed you took the chicken bones out of the sandbox before you recorded them on the chart;
2. I see there are letters and numbers on the sides of the bin;
3. I wonder if you could write down where each bone was found, just like real paleontologists do; and
4. I saw you figured out how to chart where all the bones were found! You sure stuck to that job. You should be very proud of yourself.

answers—what's important is taking the journey *with* children. Who knows? There may be a future scientist or two sitting in your classroom.

Penni Rubin runs workshops for preK–primary educators on interdisciplinary science. She can be reached at www.pennirubin.com.

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