



Start Young!

Early
Childhood
Science Activities

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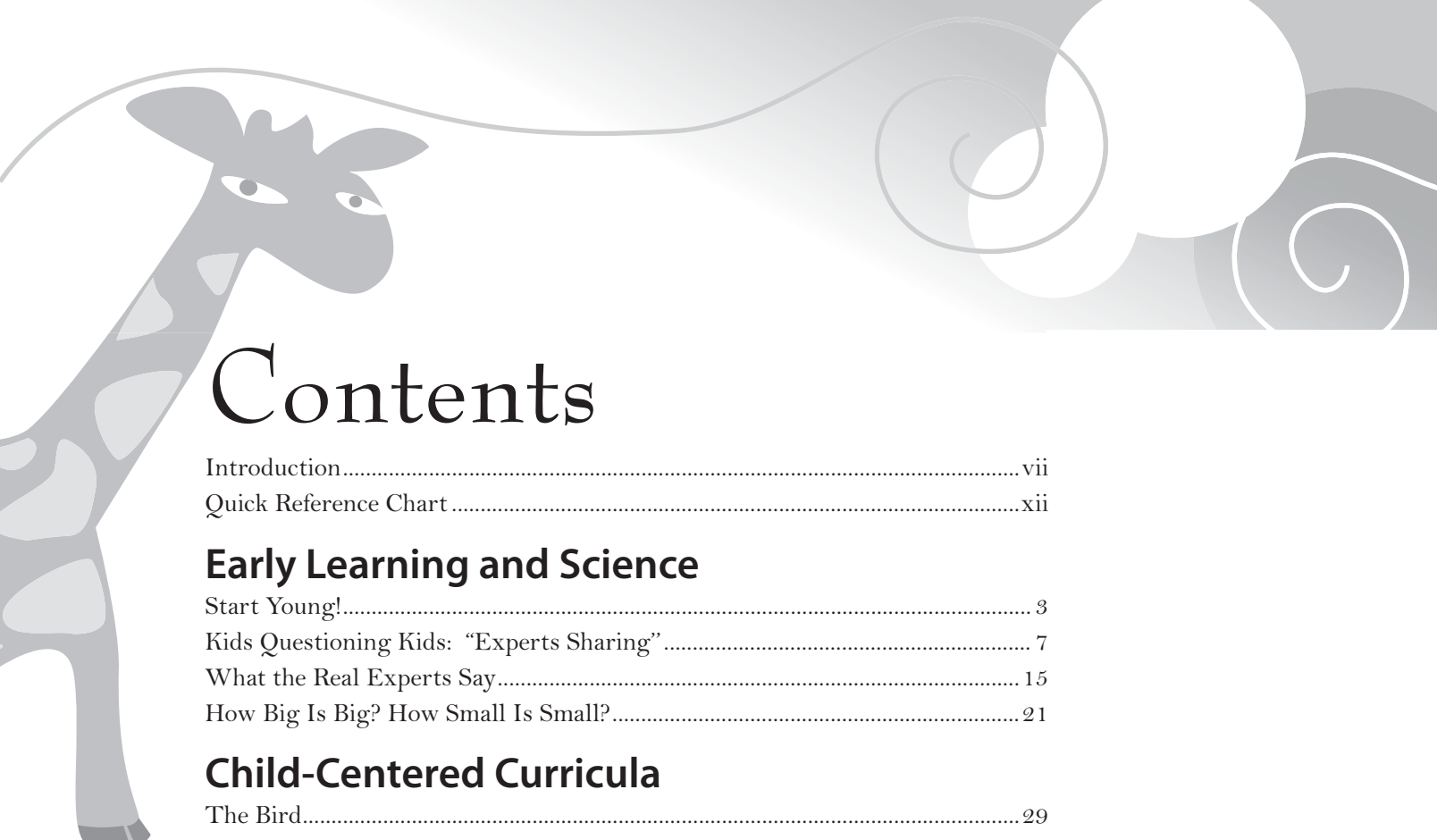
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Contents

Introduction..... vii
 Quick Reference Chartxii

Early Learning and Science

Start Young!..... 3
 Kids Questioning Kids: “Experts Sharing” 7
 What the Real Experts Say..... 15
 How Big Is Big? How Small Is Small?..... 21

Child-Centered Curricula

The Bird..... 29
 Gravitating Toward Reggio 33
 Spideriffic Learning Tools..... 39
 It’s a Frog’s Life..... 45
 Science Centers for All..... 53
 Project Reptile!..... 57
 A Science Night of Fun..... 65

Integrating Curricula

First Flight 73
 Tracking Through the Tulips..... 79
 The Science and Mathematics of Building Structures 85
 Discovery Central 93
 Ladybugs Across the Curriculum..... 97
 Miniature Sleds, Go, Go, Go!..... 105
 Journey Into the Five Senses..... 113

Assessing Understanding

Drawing on Student Understanding 121
 The Tree of Life..... 129
 Students’ Ideas About Plants 135
 Let’s Try Action Research! 145
 Playful Activities for Young Children 151
 INDEX..... 159



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 ex-

perimentation. 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 Spiderific 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 con-

duct 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 as-

sure 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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Quick-Reference Chart of Articles

Article	Standards*	Page
Early Learning and Science		
Start Young!		3
Kids Questioning Kids: Experts Sharing		7
What the Real Experts Say		15
How Big Is Big?		21
Child-Centered Curricula		
The Bird		29
Gravitating Toward Reggio	Content Standards A and B	33
Spideriffic Learning Tools	Content Standards A, C, and E	39
It's a Frog's Life	Content Standards A and C	45
Science Centers for All		53
Project Reptile	Teaching Standards A, B, C, D, and E Content Standards A, C, E, and G	57
A Science Night of Fun	Teaching Standards A, B, D, and F Professional Development Standards A, B, and C Science Education Program Standards B, C, D, E, and F	65

(continued next page)

(continued from previous page)

Article **Standards*** **Page**

Integrating Curricula		
First Flight		73
Tracking Through the Tulips	Content Standards A, C, and D	79
The Science and Mathematics of Building Structures	Content Standard A and B	85
Discovery Central	Content Standard C	93
Ladybugs Across the Curriculum	Content Standards A and C	97
Miniature Sleds, Go, Go, Go!	Teaching Standards A, B, C, and D Content Standards A, B, and E	105
Journey Into the Five Senses	Content Standards A, C, and F	113
Assessing Understanding		
Drawing on Student Understanding		121
The Tree of Life	Content Standards A, C, and F	129
Students' Ideas About Plants	Content Standard C Content Standard C for grades 5–8	135
Let's Try Action Research	Content Standards A and C	145
Playful Activities for Young Children	Content Standards A and B	151

*All Standards refer to the National Science Education Standards for grades K–4 unless otherwise noted. (National Research Council. 1996. *National Science Education Standards*. Washington, DC: National Academy Press.)



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 sev-

en; 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:

- 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.)

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

- 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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Index

- ability levels, and science learning centers 54
- access, and science learning centers 54
- activities, for young children 151–57
- Adams, D. 21
- advertisement, of Science Night of Fun 66
- age
 - early childhood and interest in science 3–4
 - and early learning of science by very young children vii–viii
 - and Playful Activities for Young Children 155–56
 - See also* grade levels; preschool children
- air
 - and growth requirements of plants 139
 - and Playful Activities for Young Children 153–54, 155
- Alaska, and The Bird project 29–31
- alternative assessments, and Playful Activities for Young Children 151–57
- animals
 - background knowledge and identification of 146–47, 148
 - integrating drawing with learning about 122–23
 - relative sizes of 22–23
 - See also* zoo; zoology
- applied learning projects 57, 59
- Arizona State University West 53
- art
 - and connection with science 121
 - and Ladybugs Across the Curriculum, 100
 - and Students’ Ideas About Plants 135–43
 - and Tree of Life 132
 - See also* collage; drawing; painting

- Arthropoda* 39
- assessment
- and Drawing on Student Understanding 121–27
 - goals and examples of x–xi
 - and Let’s Try Action Research! 145–50
 - and Playful Activities for Young Children 151–57
 - of students’ work with relative sizes 24–25
 - and Tree of Life 129–34
- Avila, Carol viii
- background knowledge, assessing of students’ before planning instruction 145–50
- bacteria, and safety 46, 47
- ballooning, by spiders 40
- Barman, Charles R. xi, 146
- Barman, Natalie S. xi
- Beckett, Carol ix
- bees, and plants 140
- benefits
- of birdwatching program 77
 - of classroom science centers 55–56
- Biggest, Strongest, Fastest* (Jenkins 1995) 22
- Bird, The, and child-centered curricula 29–31
- birds
- and bird watching program 73–78
 - and project based on found object 29–31
- black widow spider 41
- blocks, and Science and Mathematics of Building Structures 85–91
- blowing into water activity 153–54
- blueprints, for Miniature Sleds 107, 108
- bodily-kinesthetic intelligence 98, 100–101
- books
- Ladybugs Across the Curriculum* and class-published 99
 - and Tree of Life program 129–34
 - See also* literature; resources
- botany, and early childhood career learning centers 5
- See also* plants
- bottle organ activity 155
- box turtles 58
- brochure, for reptile exhibit 62
- Brown, Skila King xi
- brown recluse spider 41
- Bugs* (Parker & Wright 1987) 124

- bulbs and bulbets, and tulips 83
- Butcher, Jan x, 122
- butterflies 131

- carbon dioxide 139
- cardinals 74, 76
- careers, and interest of young children in science 4, 5
- carnivores 42
- Castellitto, Andrea ix
- celebration, and testing of Miniature Sleds designs 109–10
- centripetal force 35
- cephalothorax, of spider 39
- Chalufour, Ingrid ix–x
- Charlotte's Web* (White 1974) 41
- chickadee 76
- child-centered curricula
 - The Bird 29–31
 - It's a Frog's Life 45–51
 - Project Reptile 57–64
 - Reggio Emilia approach 33–37
 - and science learning centers 53–56
 - Science Night of Fun, 65–70
 - Spiderrific Learning Tools 39–44
- classification, of items as plants or not plants 136–37
- class projects, and Project Reptile 57–64
- classroom
 - and bird feeding station 73–74
 - and construction center for Miniature Sleds 106–107
 - and cultivating early interest in science 4
 - and early science instruction for very young children xi
 - and science learning centers 53–56
 - and Science and Mathematics of Building Structures 86–87
 - See also* discussions
- cobweb 40, 41
- Coffey, Audrey ix
- collaborative school culture 113–14
- collage, and sense of touch 116
- communication, and Kids Questioning Kids: “Experts” Sharing 7–8
 - See also* discussions; language skills; listening; questions and questioning
- community
 - and collaborative partnership with classroom 117
 - as resource for classroom science instruction 18–19

- computers
 - See* e-mail; Journey North educational program; SciLinks
- construction center, for Miniature Sleds 105
- constructivist intervention, and student misconceptions 147
- cornea, of eye 114, 116
- county agricultural extension agents 80–81
- crab spiders 40–41
- cultural objects, and science centers 54
 - See also* collaborative school culture; difference; diversity
- cup and water activity 154–55
- curriculum
 - See* child-centered curricula; integrating curricula

- dance, and Ladybugs Across the Curriculum 100–101
- data collection, and Students' Ideas About Plants 136
- Davis, Dorothy ix
- death
 - and The Bird project 30, 31
 - and It's a Frog's Life 51
- Design Technology: Children's Engineering* (Dunn & Larson 1990) 105
- DeSouza, Josephine Shireen viii–ix
- developmental spelling 58, 61
- Dias, Michael x
- Diem, Keith ix
- difference, science learning centers and celebration of students' 53–54
- Diffily, Deborah ix
- directions, for science learning centers 55
- Discovery Central xiii, 93–95
- discussions, in classroom
 - communication skills and 7–8
 - documentation of 7
 - and Ladybugs Across the Curriculum 99
 - of shadows 10–12
- dissection, of cow's eye 117
- diversity, in classrooms and science learning centers 53, 55
- docents, for reptile exhibit 62
- doctors, and visits to classroom 115–16
- Doran, Rodney ix
- do, reflect, and apply, and 4-H science programs 41
- drawing
 - and Drawing on Student Understanding project 121–27
 - and relative sizes of animals and insects 22–23
- Duckworth, Eleanor 16

- ear, and hearing 115
- early learning and science
 - How Big is Big?: How Small is Small? 21–25
 - Kids Questioning Kids: “Experts” Sharing 7–13
 - Start Young! 3–6
 - What the Real Experts Say 15–19
- Earth science, and early childhood career learning centers 5
 - See also* geology
- eggs, of frogs 45, 47–49
- e-mail, and research on reptiles 58–59
- engineering, and Miniature Sleds project 105–11
- English language, and science learning centers 54, 55
- entomologists 44, 101
- environment
 - Reggio Emilia approach and structuring of 33–34
 - and Tree of Life program 129–34
 - See also* habitat
- equinoxes 9
- evaluations, of students’ work with relative sizes 24–25
 - See also* assessment
- Exhibits
 - and Project Reptile 59–62
 - and Tree of Life 131
 - See also* open house
- experience, and exposure to science at early ages vii, viii
 - See also* observation
- Experts
 - See* doctors; nurses; scientists
- Exploration
 - See* open exploration; outdoor exploration
- Extension Service, of Department of Agriculture 41, 80–81
- eye and eyesight, and senses 114, 116, 117

- facilitators, for discussions 10, 12
- fact cards 58, 59
- Family Math program 65
- Farmer’s Almanac calendar 82
- feeling boxes 116–17
- field trips
 - and It’s a Frog’s Life 49
 - and Journey Into the Five Senses 117
 - and Let’s Try Action Research! 149
 - and Project Reptile 58

- See also* nature walks; science museums; zoo
- fifth grade, and Science Night of Fun 67
 - See also* grade levels
- First Flight program 73–79
- first grade
 - and Let’s Try Action Research! 145–50
 - and Science Night of Fun 67
 - and Tracking Through the Tulips 79–84
 - and What the Real Experts Say 15–19
 - See also* grade levels
- flight path, of birds 75–76
- float or sink activity 154
- fly away activity 153
- follow-up experiences, and program on spiders 43–44
- food, and characteristics of plants 135–36, 138, 140, 141.
 - See also* nutrition
- food chain 31
- force, Reggio Emilia approach and study of 34, 35, 36
- forest ranger, and visit to classroom 30–31
- 4-H science programs 39, 41
- 14 forest Mice and the Winter Sledding Day, The* (Iwamura 1991) 105
- fourth grade, and Science Night of Fun 67
 - See also* grade levels
- friction 35, 36
- funnel web 40

- Gardner, Howard 98, 102
- geology, and science centers 54
 - See also* Earth science
- giraffes 21, 22, 25
- gnomon 9
- Goodall Jane 3
- grade levels, and identification of plants 136–37.
 - See also* fifth grade; first grade; fourth grade; kindergarten; preschool children; second grade; third grade
- grass, and identification of plants 137, 140
- gravity and gravitational pull 35, 36
- Grouchy Ladybug, The* (Carle 1986) 98, 101
- group work, and science learning centers 54
- growth, plant requirements for 137–39
- Guha, Smita xi

- habitat, of frogs, 50

- See also* environment
- Hamm, M. 21
- Head Start program 85
- hearing, sense of 115
- height, of structures built with blocks 88–89
- Herb Kohl Educational Foundation 107
- hobbies, and early interest of children in science 4
- Hoisington, Cindy ix–x
- Horner, Jack 3
- house finch 74, 76
- How Big is Big? How Small is Small? viii, 21–25
- humans
 - identification of as animals 146–47, 148, 149
 - attribution of characteristics of to plants 135–36, 138
- hummingbirds 73, 74, 76–77
- inertia 35, 36
- inquiry-based learning strategies
 - and National Science Education Standards 7
 - and project on five senses 113–18
- insects
 - drawing and learning about 121, 122, 124, 126
 - and Ladybugs Across the Curriculum 99
 - relative sizes of, 22–23; and safety 123
 - and spiders 39–41
- integrating curricula
 - Discovery Central 93–95
 - First Flight 73–78
 - Journey Into the Five Senses 113–18
 - Ladybugs Across the Curriculum 97–103
 - Miniature Sleds 105–11
 - Science and Mathematics of Building Structures 85–91
 - Tracking Through the Tulips 79–84
- interdisciplinary teaching strategies 133
- interpersonal and intrapersonal intelligence 98, 101–102
- invertebrates, and identification of animals 146
- invitations, to reptile exhibit 62
- Irwin, Leslie ix
- It's a Frog's Life xii 45–51
- Iwasyk, Marletta viii
- Jereb, Jill viii–ix
- journal, and Ladybugs Across the Curriculum 98

- Journey Into the Five Senses xiii, 113–18
Journey North educational program 79–84
- Keller, Helen 113
Kids Questioning Kids: “Experts” Sharing 7–13
kid-watching skills 108–109
kindergarten
 and Discovery Central 93–95
 and First Flight 73–78
 and Ladybugs Across the Curriculum 97–103
 and Miniature Sleds 105–11
 and Project Reptile 57–64
 and Science Night of Fun 67
 and Tracking Through the Tulips 79–84
kitchen chemistry 5
KWHL charts 10, 94
- Ladybugs Across the Curriculum xiii, 97–103
language skills
 and Ladybugs Across the Curriculum 98–99
 Miniature Sleds and engineering terminology 109
 and vocabulary of building structures 87–88
 See also communication; English language; writing
- Learning
 and student-centered approach to science viii–ix
 Tree of Life and preparation for further 131, 133
 See also early learning and science; inquiry-based learning
 strategies; science learning centers
- learning centers
 See science learning centers
- Lego’s blocks 87
Let’s Try Action Research! xiii, 145–50
letters, and Project Reptile 58
levers
 and Miniature Sleds 109
 and Reggio Emilia approach 34
- life cycle
 of birds 31
 of frogs 49, 50, 51
 of ladybugs 100
 See also death; eggs; food chain
- Lifetimes* (Rice 1997) 23
linguistic intelligence 98–99

- listening
 - and classroom discussions 8
 - and sense of hearing 115
- Listening Walk, The* (Showers 1991) 115
- literature, relative sizes and integrating of 22–23, 25.
 - See also* books; journal
- Living Bird* (Cornell Lab) 76
- logical-mathematical intelligence 98, 99
- Lowry Center for Early Childhood Education (Michigan) 121, 122, 123, 124

- machines, and Reggio Emilia approach 33–37
- MacShara, Jeannie xi
- mammals, and identification of animals 146, 149
- materials, diversity in for science learning centers 55
- mathematics
 - and *Ladybugs Across the Curriculum* 99
 - quantification of data and integrating of science and 21
 - and *Science and Mathematics of Building Structures* 85–91
 - and *Tree of Life* 132
- McNair, Shannan x, 135
- McWilliams, Susan x
- Measurement
 - and *How Big is Big? How Small is Small?* 21–25
 - of tulips grown from bulbs 15–16
- microscope, and study of pond water 50
- Miniature Sleds, Go, Go, Go!* xiii, 105–11
- Misconceptions
 - and assessing student’s background knowledge 145–50
 - of students about plants 140, 141
- Missouri Department of Education 93
- Mitchell, Kevin ix
- models and modeling
 - design of wheels and use of 18
 - of eye 116
 - and relative sizes of animals 22
 - teachers as 126
- mold, and plants 136, 141
- molting, of insects 101
- Moriarty, Robin ix–x
- mosquito larvae, and ponds 46, 47
- motion
 - Reggio Emilia approach and study of 34
 - wheels and study of 17–18

- mover activity 154
- multiple intelligences 97–103
- museums
 - See* science museums
- mushrooms 136, 137
- music and musical intelligence
 - and bottle organ activity 155
 - and Ladybugs Across the Curriculum 98, 101
- National Council of Teachers of Mathematics Principles and Standards for School Mathematics (NCTM 2000) 86, 89
- National Science Education Teaching Standards (NSES)
 - criteria for teaching of science vii
 - Discovery Central xiii, 95
 - Drawing on Student Understanding xiii, 121
 - How Big is Big? How Small is Small? viii, xii, 21
 - and inquiry-based learning strategies 7
 - It's a Frog's Life xii, 50
 - Journey Into the Five Senses xiii, 118
 - Kids Questioning Kids: "Experts" Sharing 8
 - Ladybugs Across the Curriculum xiii, 103
 - Let's Try Action Research xiii, 150
 - Miniature Sleds xiii, 111
 - Playful Activities for Young Children xiii, 151, 157
 - Project Reptile xii, 57, 63
 - quick-reference chart for xii–xiii
 - Reggio Emilia approach xii, 35–37
 - Science Centers for All xiii
 - Science and Mathematics of Building Structures xiii, 86, 91
 - Science Night of Fun xii, 70
 - Spiderrific Learning Tools xii, 44
 - Students' Ideas About Plants xiii, 135, 136, 143
 - Tracking Through the Tulips xiii, 84
 - Tree of Life xiii, 134
 - What the Real Experts Say 15, 19
- National Science Teachers Association (NSTA), and safety guidelines 46, 123
- naturalist intelligence 98, 102
- nature walks
 - and bird watching 74–76
 - and identifying different plants and animals 147
 - and Ladybugs Across the Curriculum 102
- Nesbit, Catherine R. xi

- New Jersey 4-H Science Discovery Series 39, 41
- Newton, Isaac 17
- Nicci, Christine ix
- Nice, Margaret Morse 74–76
- nose, and sense of smell 115
- nurses, and visits to classroom 30
- nutrition, and early childhood career learning centers 5
See also food; food chain
- observation, and Journey Into the Five Senses 114
- oceanography, and early childhood career learning centers 5
- open exploration, and Science and Mathematics of Building Structures 87–88
- open house, and Science and Mathematics of Building Structures 89
- orb webs 40, 41
- ornithologist 76
- outdoor exploration, and Ladybugs Across the Curriculum 102
- oxygen, and plants 139
- painting, with objects from nature 94
- paleontology, and early childhood career learning centers 5
- paper chromatography 17
- paper spinner activity 152–53
- parents and parental involvement
 and Miniature Sleds 106, 107
 and Reggio Emilia approach 36–37
 and Science Night of Fun 66, 68, 69
- pet day 149
- photograph display, and reptile exhibit 61
- photosynthesis 139
- planning, of Science Night of Fun 65–66
- plants
 Discovery Central and science learning centers 93–95
 growing tulips from bulbs and measurement of 15–16
 and Students' Ideas About Plants 135–43
 and Tracking Through the Tulips program 79–84
 See also botany
- Playful Activities for Young Children xiii, 151–57
- Plummer, Donna M. xi
- pond water, and It's a Frog's Life 46, 47, 49–50
- positive reinforcement, and Science Night of Fun 68–69
- posttest, and identification of plants and animals 148
- practicing, of identification of plants and animals 147–48

- predators 42
- preschool children
 - and *It's a Frog's Life*, 45–51
 - and *Science and Mathematics of Building Structures* 85–91
- preservice teachers, and *Science Night of Fun* 65–66, 68–69
- Primarily Plants* (Hoover and Mercier 1990) 93
- Project Reptile xii, 57–64
- pulleys, and Miniature Sleds project 109

- questions and questioning
 - and building structures with blocks 88–89
 - and development of communication skills for modeling 8, 12
 - and program on frogs and tadpoles 48

- rain forest
 - animals of 124–25
 - and Tree of Life program 129–34
- Rain Forest* (Cowcher 1990) 131
- rat snakes 58
- reading, and thematic web for Tree of Life 132
- reflection, and *Ladybugs Across the Curriculum* 101–102
 - See also* do, reflect, and apply
- Reggio Emilia approach xiii, 33–37
- reinforcing, and identification of plants and animals 147–48
 - See also* positive reinforcement
- reptiles, and Project Reptile 57–64
- research
 - and learning about reptiles 58–59
 - and *Let's Try Action Research!* 145–50
- resources
 - and bibliography for *Ladybugs Across the Curriculum* 100
 - community, a 18–19
 - for *Drawing on Student Understanding* 126
 - trade books and Tree of Life 133
 - See also* SciLinks
- Rommel-Esham, Katie ix
- roots, of plants 139
- Rubin, Penni viii

- Safety
 - and handling of dead bird 29
 - and spiders 41
 - and tools 107–108

- and wading pools or ponds 46, 47
- with insects and animals 123
- Sammy's Science House CD-ROM (Edmark 1996) 108
- sapsuckers 77
- Sarow, Gina x
- Scheduling
 - for Reptiles Exhibit Project 57
 - of time for science learning centers 54
- science
 - connecting drawings with 121, 124
 - and early learning by very young children vii–viii
 - and student-centered approach to learning viii–ix
 - and thematic web for Tree of Life 132
 - See also* early learning and science; science learning centers; scientists
- Science and Children* 25, 46, 135, 141, 145, 149
- Science Centers for All xii, 53–56
- science learning centers
 - career-oriented for early childhood 5
 - and Discovery Central program 93–95
 - and Ladybugs Across the Curriculum 99
 - and Science Centers for All program 53–56
- Science and Mathematics of Building Structures xiii, 85–91
- science museums
 - and Journey Into the Five Senses 117
 - and Project Reptile 58, 61
- Science Night of Fun xii, 65–70
- Scientists
 - and interviews about early interest in science 3
 - inviting to classroom 4, 44, 101, 124–25
 - and studies of historic figures 17, 74–76
 - See also* doctors; nurses
- SciLinks
 - and birds 75
 - and insects 122
 - and reptiles 58
 - an senses 114
 - and simple machines 34
- second grade
 - and How Big is Big? How Small is Small? 21–25
 - and Science Night of Fun 67
 - and Tracking Through the Tulips 79–84
 - See also* grade levels

- seeds: and Discovery Central program 94, 95
 - and Students' Ideas About Plants 137
- senses, and Journey Into the Five Senses 113–18
- shadows, and activity suggestions 9, 10–12
- sheet web 40
- show-and-tell time 8
- simplicity, in directions for science centers 55
- size, and How Big is Big? How Small is Small? viii, 21–25
 - See also* measurement
- smell, sense of 115
- social skills, and Ladybugs Across the Curriculum 101
- soil, and plants 81, 140
- solstices 9
- songs, and Ladybugs Across the Curriculum 101
- Spiderrific Learning Tools xii, 39–44
- spiders, and Spiderrific Learning Tools 39–44
- spider webs 40, 41, 42–43
- spinnerets, of spiders 39, 40
- spiracles, of insects 22
- Start Young! 3–6
- State University of New York College at Genesco 65
- Stein, Mary x, xi, 135
- Sterling, Donna ix
- Still More Activities that Teach* (Jackson 2000) 110
- Stokes Beginner's Guide to Birds* (Stokes and Stokes 1996) 73, 74
- Stovall Ginger, xi
- Students' Ideas About Plants xiii
- STUFF (Stimulating Tools Useful for Fun and Fundamentals) 4, 5
- Successlink (Missouri Department of Education) 93
- sunplot/shadow board 9
- sun and sunlight
 - activity suggestions for plots and shadows 9
 - and growth requirements of plants 138–39, 140
 - and Tracking Through the Tulips 82–83

- tadpoles 45, 47, 48–49
- take home activities, and Science Night of Fun 67, 68
- tape recorders
 - and directions for science centers 55
 - and documenting classroom discussions 7
- tarantulas 39–40
- taste, and senses 115–16
- teachable moments 45

- teachers and teaching
 - implications of student misconceptions about plants and animals for 141, 149
 - and professional development workshop 80
 - as role models 126
 - See also* classroom; learning; preservice teachers
- Tennessee Science Teachers Association 79
- terrariums, and frogs 50, 51
- testing, of Miniature Sleds designs 109–10
 - See also* assessment; evaluation; posttest
- thematic web, and Tree of Life 129–30, 132, 133
- think-pair-share strategies 101
- third grade, and Science Night of Fun 67
- thorax, of insect 124
- Tigger's Contraptions CD-ROM (Disney 1997) 108
- Time
 - See* scheduling; timeline
- timeline, for reptiles exhibit project 60
- titmice 76
- tongue, and sense of taste 115–16
- tools, and Miniature Sleds project 107–108
- touch, sense of 116–17
- towers, and building structures with blocks 88–89
- Toyota Tapestry Grant 79, 80
- Tracking Through the Tulips xiii, 79–84
- tree(s)
 - and identification of plants 136, 137, 140
 - and The Tree of Life program 129–34
- Tree of Life, The xiii 129–34
- Tree of Life: The World of the African Baobab* (Bash 1989) 129–34
- trial and error, and building structures with blocks 87
- tulips 15–16, 79–84

- U.S. Department of Agriculture 41
- U.S. Geological Survey 3
- Universities
 - and bird watching program, 74
 - and Science Night program 65–70
- University of Alaska–Southeast 29
- University of Colorado at Denver 113
- University of Washington 8
- Upland Hills School (Michigan) 121, 123

- Venn diagram 86, 89–90
- verbal-linguistic intelligence 98
- video cameras, and documenting classroom discussions 7
- vision
 - See* eye and eyesight
- visual-spatial intelligence 98, 99–100
- Vygotsky L. S. 16

- Ward, Christina Dias x
- Warren on Wheels Festival 18–19
- water, and plant growth 139
 - See also* pond water
- West Nile virus 47
- What the Real Experts Say 15–19
- What's Smaller Than a Pygmy Shrew* (Wells 1995) 23
- wheels, and study of motion 17–18
- Whitin, Phyllis ix
- Winokur, Jeff ix–x
- Wisconsin, and Miniature Sleds project 105
- wondering, science as 8
- Wood, Jaimee x
- woodpeckers 77
- worms 140
- Worth, Karen ix–x
- writing, and thematic web for Tree of Life 132
 - See also* books; developmental spelling; journal; letters; literature

- zone of proximal development 16, 17
- zoo, and field trips 58, 149
- zoology
 - and early childhood career learning centers 5
 - rain forest animals and visit to classroom by zoologist 124–25