in the early years

Science in the Air

Sherrie Bosse,
Gera Jacobs, and
Tara Lynn Anderson

"Teacher, can we try to make square bubbles?"

"How come leaves don't turn blue in the fall?"

"Will our seeds grow if we water them with orange juice?"

YOUNG CHILDREN are naturally curious. The desire to question, hypothesize, explore, and investigate is part of their very being. This inherent sense of inquiry provides the foundation for science with young children, from inquisitive toddlers to curious third-graders.

Early childhood educators can build on children's questions, eagerness, and enthusiasm to help them learn science. We can foster scientific knowledge by thoughtfully preparing rich environments, indoors and out; by introducing a scientific vocabulary during engaging activities and long-term studies or themes; and by providing many opportunities for children to problem solve and investigate. Science, like the very air around us, can infuse life into our programs.

Creating an environment that promotes science

One easy way to incorporate science into the daily classroom routine is to set up a discovery area where children can explore. This can be on a table or shelving unit or in another creative space. The key to designing a quality discovery area is carefully selecting a variety of age-appropriate materials (such as magnifiers, a balance scale, prisms, and plants) that will introduce children to the wonders of the natural world. Rotate additional natural materials, books, and manipulatives to reinvigorate interest and reflect seasonal changes.

Very young children relish the tactile sensations of smooth shells, fuzzy cattails, and rough pinecones. As children grow and develop, they begin to formulate and answer questions by using tools and materials to measure, observe, weigh, and record their findings. At first, teachers may need to model the use of some materials and help children consider the best types of tools to use in their explorations. We can ask open-ended questions that model the inquiry process: "I wonder how we could find out how

Sherrie Bosse, EdD, is an associate professor in curriculum and instruction at the University of South Dakota in Vermillion. Sherrie has 21 years of experience in early education as a teacher, administrator, and teacher educator. Her research interests include early learning environments and teacher preparation. sbosse@usd.edu

Gera Jacobs, EdD, is a professor of early childhood education at the University of South Dakota. She is a member of the NAEYC Governing Board. Gera began her career as an elementary science teacher and taught preschool through eighth grade for many years. Gera.Jacobs@usd.edu

Tara Lynn Anderson, MA, is an elementary school teacher in Sioux Falls, South Dakota, and has taught preschool through fifth grade. Tara has presented at national and state conferences, sharing her ideas for involving young children in hands-on science. Tara.Anderson@usd.edu

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many tiny seeds are in a single pod?" By using descriptive words with the materials, we introduce children to vocabulary that will grow along with their investigations of the world.

In addition to defining a discovery area, teachers can integrate materials that support science inquiry in all areas of the room, helping children learn science concepts as well as literacy, math, and more. Add both fiction and nonfiction books with science themes to the classroom library as well as to the writing, housekeeping, and block areas. Place a balance scale, a basket of materials of different sizes and weights, and graph paper in the math area. For the water table, provide a variety of objects, such as different measuring containers, tubing, and items that children can use to explore sinking and floating. Supplement a bird feeder visible from a classroom window with an illustrated field guide, binoculars, and a clipboard for documenting the numbers and types of winged visitors.

The best investigation topics are those that children encounter on a daily basis and that allow for hands-on inquiry.

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The outdoor environment is a rich area for scientific exploration. As children of all ages view the veins of a leaf in sunlight, discover that rocks become a much richer color when wet, or inhale the scent of a lilac bush in full bloom, their curiosity leads to questions and fosters connections to the natural world.

Some playgrounds lack nature, and with it, firsthand opportunities for children to explore, discover, and build scientific vocabulary. When teachers add planter boxes or small garden plots to the outdoor areas, children can plant and care for flowers or vegetables. Gardening is fertile ground for predicting, comparing, and observing the characteristics of living things; the experiences may prompt long-term studies of growing cycles, food chains, or habitats. Gardens, shrubs, and trees attract birds, butterflies, and insects that lead children to ask questions about the natural world.

Some outdoor spaces include a gathering area for discussions or read-alouds. Books relating to the things that children are noticing and wondering about are especially engaging. Some programs set up an outdoor art area where children can create with natural materials, a music area, a building area, a messy play area, or a water feature (National Arbor Day Foundation 2007).

Undertaking in-depth explorations

Long-term studies or projects focusing on science-related topics let children achieve a much deeper understanding of scientific concepts than do isolated activities or experiences. The topic of study depends on the children's interests and the resources available. Note the topics that children raise in conversations—perhaps the wildlife in your area, the water system, seasonal changes, mechanical operations (elevators, dump trucks, cranes), or recycling. Consulting the applicable science content standards for the age level you teach and considering the firsthand opportunities with the subject matter also can help you choose a topic. The best investigation topics are those that children encounter on a daily basis and that allow for hands-on inquiry.

As children get older, we can encourage them to predict and try out different conditions, enhancing their understanding of the influence of light, soil, and water on the growth and development of plant life.

Once you and the children have chosen what to study, involve them in researching the topic. Read books and articles, look up information on the Web, and explore other sources of information on the topic. Resources for researching children's questions are generally abundant, and the information can be connected to other areas of daily life (Helm & Katz 2001; Worth & Grollman 2003). Invite knowledgeable members of the community to come in and share their expertise. Visit places where children can learn firsthand about the topic—they may be as close as your playground or a nearby park.

Encourage children to represent what they are learning through drawing, writing, and photography. Display their work on documentation panels in the classroom or hallway. Create class books documenting each stage of the inquiry process through photos, children's quotes, and some teacher commentary. Bind the pages in photo albums or laminate and secure them with metal rings or plastic binding combs. Class-created books about long-term investigations allow children to revisit prior learning and to read and reflect. Children can take turns taking home the books to share with their families.

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Meeting science standards—"It's a breeze"

Science standards outline age- and grade-appropriate concepts. The National Science Education Standards (NRC 1996) include content standards for K–4. They can be accessed free online at www.nap.edu/catalog.php?record_id=4962. The content standards include the areas of

- Science as Inquiry (pp. 121–23 online)
- Physical Science (pp. 123–27)
- Life Science (pp. 127–29)
- Earth and Space Science (pp. 130–34)
- Science and Technology (pp. 135–38)
- Science in Personal and Social Perspectives (pp. 138–41)

Although some of these areas may seem too complex for younger children, the standards can guide teachers in selecting engaging, hands-on experiences and activities suited to children's developmental levels.

Science as Inquiry. Frequent opportunities to predict, investigate, estimate, classify, and graph hone children's inquiry skills. Modeling the use of "I wonder . . .", "What if . . . ?" and "How can we find out?" introduces children to the basis of science inquiry. When children pose a question, we can introduce the process of observing, researching, creating and testing hypotheses, and collaborating to find answers. Write questions on a flip chart and revisit them during the inquiry process. This helps children realize that it takes time to understand some things and that we don't need to give up when an answer isn't readily available.

Physical Science. Hands-on exploration of readily accessible materials encourages children to investigate the properties of objects. In the block area, for example, cardboard tubes and lengths of plastic rain gutters or cove molding, along with balls and things with wheels, help children develop notions about the position and motion of objects as they create ramps and tunnels. At the water table, tubing, measuring cups, funnels, turkey basters, and eyedroppers foster beginning understandings of volume, weight, gravity, and force.

Life Science. Through observation, children can formulate questions about the characteristics of living things and measure, record, discuss, and think about their observations. Planting seeds and watching the changes that take place over time is a meaningful activity for children of all ages. As children get older, we can encourage them to predict and try out different conditions, enhancing their understanding of the influence of light, soil, and water on the growth and development of plant life. Observing animals in their natural habitats (birds, squirrels, insects, and worms seen on the playground or in a nearby park) or caring for classroom pets helps children develop a deeper understanding of living things. Hatching chicks in an incubator, watching fish in a small aquarium, or observing a butterfly's amazing transformation cycle invites rich classroom discussions and allows older children to record and document their observations.

Earth and Space Science. Young children can record the number of sunny versus cloudy days, check the playground rain gauge and record precipitation, and notice the effect of wind direction on a windsock. A special rock brought back from a family vacation may spark interest in examining, categorizing, and classifying different types of rocks. Simply playing at the sand and water tables develops familiarity with the properties of earth materials.


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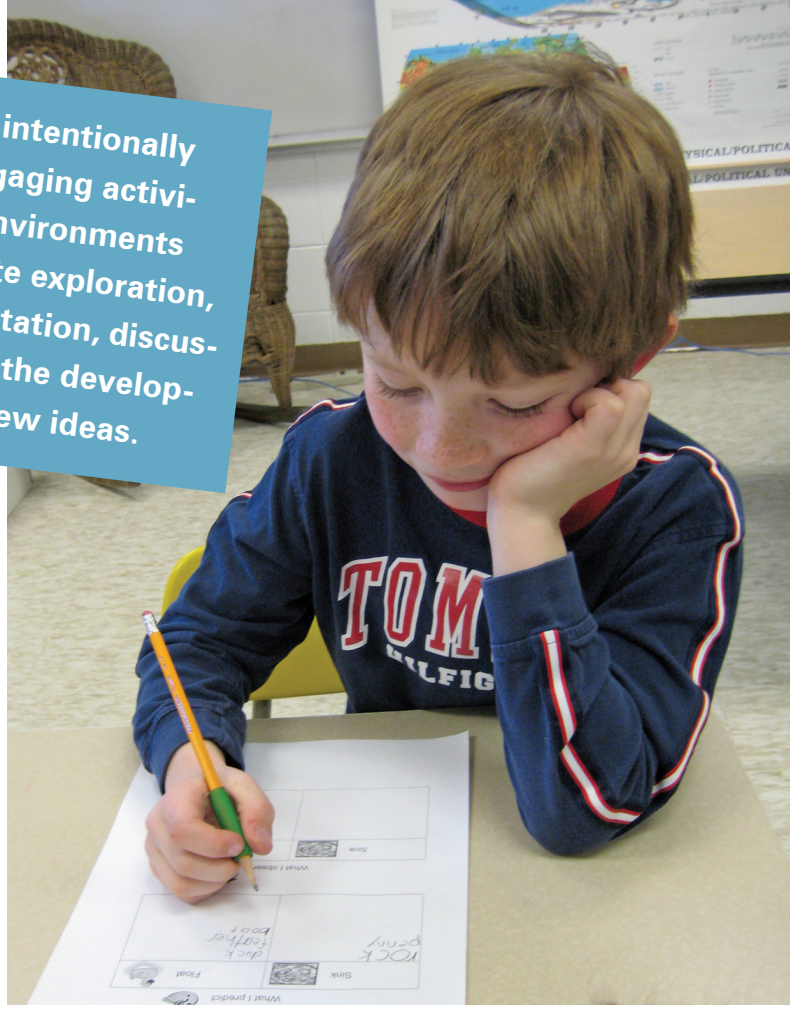
Science and Technology. Distinguishing between natural items and man-made items can enhance children's understandings of science and technology, especially the technological tools that have become part of our daily lives. Simple machines (such as apple peelers, ice cream churns, and egg timers) invite hands-on investigations of how machines function. Opportunities for children to use developmentally appropriate software and digital cameras can be catalysts for curiosity and wonder.

Science in Personal and Social Perspectives. Discussions and activities about conserving resources and recycling bring science into personal and social perspectives. Brainstorming ways to repurpose discarded objects develops problem-solving skills and higher order thinking. Teachers can spark children's consideration of how we each impact the environment by sharing a story from the library or creating their own, possibly leaving the ending to the imaginations of the listeners. Making paper offers

a hands-on lesson in recycling and changes in matter. Children tear up old construction paper (a great fine motor activity), put the scraps in a blender with water, spread the mixture on an old window screen or other mesh material, and let the pulp dry for several days. The handmade paper makes an interesting addition to the art area. Children can immerse themselves in scientific roles when we add props for health care professions or ecology themes to the dramatic play area, organize field trips, or arrange classroom visits by professionals in those areas.

We can intentionally plan engaging activities in environments that invite exploration, documentation, discussion, and the development of new ideas.



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Building higher order thinking skills and positive approaches to learning

When children consider the reasons behind events or phenomena, they can better understand scientific concepts than when asked to recall facts or answer yes/no questions. Thoughtful teachers help children expand on initial responses and observations to analyze (examine how and why), compare and contrast (distinguish between *same* and *different*), and problem solve (envision possible solutions and weigh their advantages and disadvantages).

Teachers can ask open-ended questions and provide ample opportunities for practice to foster the ability to make connections between ideas, link past and current events, and identify patterns or sequences. Problem solving is an invaluable skill often rooted in our early experiences. We all encounter the occasional daunting task, but the choice between "I can't" and "I'll try" often predicts the outcome of the challenge. Children gain insight into negotiating challenging situations when they hear and see us thinking aloud, talking through a problem: "We have some birdseed, but we don't have a bird feeder. How can we feed the birds? We have to think of a way to solve this problem. There are a lot of materials in our recycling box. Shall we see if we can make a bird feeder from some of those items?" Taking advantage of teachable moments to involve children in problem solving can help them develop the skills to independently and successfully meet future challenges.

Science is in the air

Science is part of our everyday lives, and every day is filled with science possibilities. Children can share questions and ideas during class meetings and circle times. Displaying photos and documentation of science explorations can help children revisit past investigations and connect new information to prior experiences. Open-ended questions and invitations to try out predictions (hypotheses) empower children to actively seek answers. Science vocabulary interspersed in daily exchanges builds on children's curiosity and desire to understand the world (see "Building Language and Scientific Literacy").

Exploration and inquiry come naturally to children. Adults can nurture this curiosity, helping children develop science inquiry skills and higher order thinking. We can intentionally plan engaging activities in environments that invite exploration, documentation, discussion, and the development of new ideas. When science is in the air, infused into daily classroom life, we encourage wonder and help children develop a greater appreciation of the world and their place in it.

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Building Language and Scientific Literacy

Helping children expand their vocabulary is one of the best ways to ensure that they become successful readers and writers (Tabors, Snow, & Dickinson 2001). It is also an effective way to help children learn science concepts. To think through and explain why something might happen and why something might work, children need to have the words to express these thoughts.

Add science vocabulary words to a classroom word wall. Model the use of terms such as *estimate*, *predict*, *atmosphere*, and *habitat* in day-to-day conversation and encourage children to use the vocabulary themselves: "You're right, Casey. The vinegar bubbled up when you added the baking soda—just as you predicted it would. What other mixtures would you like to investigate?" As children build their literacy skills, provide forms for recording observations so they can also grow in their inquiry skills and practice using scientific vocabulary. Language modeling and concept development (Pianta, LaParo, & Hamre 2008) can make a real difference in children's learning.

1. Model science-related vocabulary, using scientific terms as children interact with engaging materials and planned experiences.

2. Encourage meaningful conversations and expand on what children say.

3. Provide many opportunities for using science-related language and engaging in hands-on experiences that deepen children's understanding of the words.

4. Ask open-ended questions that promote predicting skills and teach problem-solving skills: "Now that we've frozen water into all these interesting shapes, which of them do you think will melt most quickly? Let's write down our predictions. How can we find out if we're right?" Let children make their own predictions, try things out, and note what works and why.

5. Use words to describe our actions and the children's actions: "I'll pour this water into the cup of cornstarch as you stir. Let's observe what happens as we try to pick up the interesting mixture we've just made. Is it more like a solid or a liquid?"

Science
in the early years

"Science in the Air" opens this cluster on teaching and learning about science in the early childhood years. Authors, **Sherrie Bosse, Gera Jacobs,** and **Tara Lynn Anderson** discuss creating environments that promote science, undertaking in-depth explorations, meeting science standards, and building higher order thinking skills and positive approaches to learning for "inquisitive toddlers to curious third-graders." They introduce concepts and strategies that are further explored in the articles that follow.

"Toddlers' Scientific Explorations: Encounters with Insects," by **Lauren Foster Shaffer, Ellen Hall,** and **Mary Lynch,** describes a long-term investigation by toddlers. The teachers responded to the children's "messing about" through a three-phase approach to guide children's science learning. The authors explain the strategies they used to encourage the children's explorations and provide work samples that document the children's scientific thinking.

In "Using Children's Books to Teach Inquiry Skills," **Mesut Saçkes, Kathy Cabe Trundle,** and **Lucia Flevares** provide a useful list of children's literature tied to specific science concepts, suggested inquiry activities, and the targeted inquiry skills relating to each title. The selected books allow teachers to integrate literacy and science learning and promote children's inquiry skills.

"Reading, Writing, and Conducting Inquiry about Science in Kindergarten," by **Helen Patrick**, **Panayota Mantzicopoulos,** and **Ala Samarapungavan,** describes a series of study units with sequences of integrated science inquiry and literacy activities. Pages from children's science notebooks illustrate how the approach allows children to document their science questions, observations, and conclusions, while building writing and reading skills.

"Science Learning at Home: Involving Families," by **Elizabeth Outlaw Crawford, Emily T. Heaton, Karen Heslop,** and **Kassandra Kixmiller,** reinforces the notion that children can learn science concepts and develop science skills through a variety of experiences at school, at home, and in the community. To demonstrate this, the authors provide a handout for families that shares ideas for engaging family activities that help children to build understandings of specific science concepts.

Alyse C. Hachey and **Deanna L. Butler,** authors of "Seeds in the Window, Soil in the Sensory Table: Science Education through Gardening and Nature-Based Play," are enthusiastic supporters of gardening and nature-based curriculum. Their numerous, practical suggestions are easy to implement in any preschool classroom—including those in urban settings.

"Engage, Investigate, and Report: Enhancing Children's Natural Wonder," by **Sally Blake,** reports on new guidelines for teaching children the scientific method and introduces approaches that emphasize the hands-on nature of science teaching and learning in the early years. Using the example of an investigation of worms by 3- and 4-year-olds, Blake outlines the five phases of the science inquiry cycle.

Kimberly Brenneman, author of "Let's Find Out! Preschoolers as Scientific Explorers," describes a curricular approach that engages children in simple investigations as part of classroom explorations of scientific concepts and themes. She reports on the science experiences of children engaged in two explorations, an investigation of seasonal changes and a study of plants and growth.

"Of Water Troughs and the Sun: Developing Inquiry through Analogy," by **Kay W. Cowan** and **Sandra Cipriani,** shares an approach to teaching scientific inquiry to first-graders. Each lesson emphasizes observation, drawing, attending to details, and writing poetry, thus positioning children to think metaphorically.

—Derry Koralek, Editor in Chief

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