Science
in the Air

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Young children are naturally curious. The desire to **Creating an environment that promotes** question, hypothesize, explore, and investigate is part of **science** their very being. This inherent sense of inquiry provides the foundation for science with young children, from inquis One easy way to incorporate science into the daily itive toddlers to curious third-graders.
classroom routine is to set up a discovery area where Early childhood educators can build on children's ques
children can explore. It can be on a table or shelving unit tions, eagerness, and enthusiasm to help them learn sci or in another creative space. The key to designing a qual ence. We can foster scientific knowledge by thoughtfully ity discovery area is carefully selecting a variety of age preparing rich environments, indoors and out; by introduc- appropriate materials (such as magnifiers, a balance scale, ing a scientific vocabulary
prisms, and plants) that during engaging activities and
will introduce children to long-term studies or themes;
the wonders of the natural and by providing many

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

world. Rotate additional nat opportunities for children to
ural materials, books, and **"How come leaves don't turn blue in the fall?"**
problem solve and investi
manipulatives to reinvigo gate. Science, like the very air
"Will our seeds grow if we water them with
rate children's interest and around us, can infuse life into orange juice?
reflect seasonal changes. our programs.
Very young children rel ish the tactile sensations of smooth shells, fuzzy cattails,
and rough pinecones. As **Sherrie Bo**sse, EdD, is a senior lecturer in curriculum and instruc
children develop and learn, they begin to formulate and tion at the University of South Dakota in Vermillion. Sherrie has 25 years of experience in early education as a teacher, administrator,
answer questions by using tools and materials to measure, and teacher educator. Her

research interests include early learning observe, weigh, and record their findings. At first, teach environments and teacher preparation.
ers may need to model the use of some materials and help **Gera Jacobs**, EdD, is a professor of early childhood education at children consider the best types of tools to use in their the University of South Dakota. She is president of the NAEYC explorations. We can ask open-ended questions that model Governing Board. Gera began her career as an elementary science
the inquiry process: "I wonder how we could find out how teacher and taught preschool through eighth grade for many years,
many tiny seeds are in a single pod?" By using descriptive **Tara Lynn Anderson-Topete,** MA, is an elementary school teacher
words with the materials, we introduce children to vocabu in Sioux Falls, South Dakota, and has taught preschool through fifth grade. Tara has presented at national and state conferences, shar lary that will grow along with their investigations of the ing her ideas for involving young children in hands-on science. world.

In addition to defining a discovery area, teachers can integrate materials that support science inquiry in all areas

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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 and to the writing, dramatic play, 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, pro vide a variety of objects, such as different measuring con tainers, tubing, and items that children can use to explore sinking and floating. Hang a bird feeder outside so it is visible from a classroom window, and provide an illustrated field guide, binoculars, and a clipboard for documenting the number and types of winged visitors. 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 the corresponding 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 The best
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, and that allow 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; Rivkin, forthcoming).

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 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.

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 2011; Moomaw 2013). Invite members of the community who know about the topic 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 pictures, writing, and taking photographs. Children's work can be displayed on documentation

panels hung in the room or hallway, or be made into class books,

which allow children to continue to learn from their experiences. Class books documenting the study can include photos of each stage of the inquiry process, accompanied by children's quotations and some teacher commentary. Teachers can insert the pages into ready-made photo albums, or laminate the pages and secure them with metal rings or plastic binding combs. Class-created books about long-term investigations allow children to revisit prior learning and encourage both reading and reflection.

Meeting science standards—"It's a breeze"

Science standards outline age- and grade-appropriate concepts. Many state early learning guidelines include preschool science standards, and the National Research Council's (NRC) framework for science education (NRC 2012) outlines broad concepts for students to acquire over the years, from kindergarten through grade 12. (The report, A *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas,* is free online at www. nap.edu/catalog.php?record_id=13165.)

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The framework includes three dimensions, or strands, that need to be integrated into standards, curricula, instruction, and assessment:

• Scientific and engineering practices . Crosscutting concepts

• Core ideas in four disciplinary areas: physical sciences, life sciences, earth and space sciences, and engineering, technology, and applications of science

Although some of these areas may seem too complex for young children, your state's early learning guidelines and the NRC science education framework can guide teachers in selecting engaging, hands-on experiences and activities suited to children's developmental levels.

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Scientific and engineering practices

Frequent opportunities to predict, investigate, estimate, classify, and graph enable children to develop inquiry skills—that is, scientific and engineering practices (NRC 2012)—that they will continue to build on. By modeling the use of "I wonder . . . ?," "What if. . . ?," and “How can we find out?," teachers introduce children to the basis of science

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

inquiry. When children pose a question, an opportunity arises to introduce the process of researching a question, 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 they don't need to give up when an answer isn't readily available.

Crosscutting concepts

Seven crosscutting concepts give learners ways to con nect knowledge from various disciplines into a coherent scientific view of the world. Guiding children's discovery of the patterns around them is a natural start to helping children grasp the concept of *patterns*, which cuts across all scientific understandings. With our support, children can map and document the movement of the sun across the sky each day and measure and record the lengths of shadows on the playground at different times of the day. Children can experience c*ause and effect* when they push down the first domino

in a line and watch the others fall, or experiment with the angle of a ramp and the distance that a ball travels when rolled down the ramp. They learn about

scale as they arrange blocks or toys from largest to small est. Learning about their bodies or the parts of a plant they grow from a single seed helps them grasp the concept of s*ystem.* An early foundation for understanding *energy and matter* can be fostered when children join together manipu latives to create a larger object. Comparing the weight of the manipulatives as separate pieces to the weight of the same pieces joined together leads to an understanding that the weight of matter stays consistent. Opportunities to examine turtle and snail shells can inspire discussions about how some animals have external parts that help them survive, introducing the concept of *structure and func tion.* Children discover more about *stability* as they build with blocks, and about *change* as they record the height of a snow drift over several days.

Core ideas in four disciplinary areas

Core ideas in science are taught over multiple grade levels, growing in complexity as children build their depth of understanding. They are ideas that relate to children's

interests and experiences, and are key to understanding one or more science disci

Thoughtful teachers plines. Core ideas give children the tools

help children expand to understand the world around them and to solve the problems they encounter

on initial responses and (NGSS 2013).

observations to analyze,

compare and contrast, Physical sciences. Hands-on explo ration of readily accessible materials

and problem solve. encourages children to investigate properties of objects. In the block area, for example, cardboard tubes and lengths of plastic rain gutter 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, tubes and measuring cups, funnels, turkey basters, and eyedroppers foster beginning understandings of volume, weight, gravity, and force.

Courtesy of the authors
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Life sciences. Through observation, children can formu late questions about the characteristics of living things and measure, record, discuss, and think about their observa tions. 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 pre dict and try out different conditions, enhancing their under standing 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 under standing 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 dis cussions and allows older children to record and document their observations.

science and technology, especially the technological tools that have become part of our daily lives. Simple machines (apple peelers, ice cream churns, egg timers) invite hands on investigations of how machines function. Opportunities for children to use developmentally appropriate software, apps, and digital cameras can also be catalysts for curiosity and wonder.

Building higher order thinking skills and positive approaches to learning

Earth and space sciences. Young children can record the number of sunny versus cloudy days, check the play ground 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.

Engineering, technology, and applications of science. The framework for science education (NRC 2012) states that by the end of second grade, students should be able to ask questions, make observations, gather information, draw representations of their findings, and find multiple solutions to problems. We can build these skills as we model and encourage exploration and help children docu ment the process. Distinguishing between natural items and man-made items can enhance children's understandings of

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 ques tions. 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 solv ing is an invaluable skill often rooted in our early experi ences. We all encounter the occasional daunting task, but the choice between “I can't" and "I'll try" often predicts the

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Building Language and Scientific Literacy

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mixtures would you like to investigate?" As children build their literacy skills, provide forms for recording observations so they can also improve their scientific practices and use scientific vocabulary. Language modeling and concept devel-3 opment (Pianta, LaParo, & Hamre 2008) can make a real difference in children's learning. Helping children expand their vocabu- lary is one of the best ways to ensure that they become successful readers and writers (Schickedanz & Collins 2013). Its is also an effective way to help children learn science concepts. To think through and explain why something might hap pen 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 e*stimate, 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

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 pre dictions, 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?"

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.

outcome of the challenge. Children gain insight into nego tiating 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 inde- pendently and successfully meet future challenges. 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.

References

Science is in the air

Science is part of our everyday lives, and every day is filled with science possibilities. Children can share ques tions and ideas during class meetings and circle times. Displaying photos and documentation of science explora tions can help children revisit past investigations and con nect new information to prior experiences. Open-ended

questions and invitations to try out predictions (hypoth eses) empower children to actively seek answers. Science vocabulary interspersed in daily exchanges builds on chil dren'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 scientific and engineering practices, and higher-order thinking. We

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